DEUTSCHE internationale Zeitschrift

für zeitgenössische Wissenschaft

№134
2026

DIZZW 2020

DEUTSCHE internationale Zeitschrift
für zeitgenössische Wissenschaft

DIZZW 2020

DEUTSCHE internationale Zeitschrift
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ISSN (Print) 2701-8369
ISSN (Online) 2701-8377

Deutsche internationale Zeitschrift für zeitgenössische Wissenschaft

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№134 2026

Deutsche internationale Zeitschrift für zeitgenössische Wissenschaft ist eine internationale Fachzeitschrift in deutscher, englischer und russischer Sprache.

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№134 2026

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Artmedia24

Anschrift: Industriestraße 8,74589 Satteldorf Deutschland.

E-mail: info@dizzw.com
WWW: www.dizzw.com

Chefredakeur: Reinhardt Roth

Druck: Einzelfirma Artmedia24, Industriestraße 8,74589 Satteldorf Deutschland

Artmedia24

Address: Industriestrasse 8,74589 Satteldorf Germany.

E-mail: info@dizzw.com
WWW: www.dizzw.com

Editor in chief: Reinhardt Roth

Printing: Artmedia24, Industriestrasse 8,74589 Satteldorf Germany.

Der Redaktionsausschuss der Zeitschrift ist nicht verantwortlich für die veröffentlichten Materialien.

Für den Inhalt der Artikel sind die Autoren verantwortlich
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Bei Nachdrucken muss die Zeitschrift zitiert werden.

Das Material wird im eigenen Wortlaut des Autors veröffentlicht.

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In case of materials reprinting - link to journal is required.
Materials are publishing in author's edition.

Edition: № 134/2026 (August) – 134th

Passed in press in August 2026

Printed in August, 2026

Printing: Artmedia 24, Industriestrasse 8,

74589 Satteldorf, Germany.

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ARTS

ARTIFICIAL INTELLIGENCE IN MUSIC EDUCATION: OPPORTUNITIES, CHALLENGES, AND PEDAGOGICAL PERSPECTIVES

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Abstract

Artificial intelligence (AI) has become an important component of modern education, offering new opportunities to improve teaching and learning processes. In music education, AI technologies support personalized learning, creative development, and innovative teaching practices through intelligent digital tools. The purpose of this study is to examine the role of artificial intelligence in modern music education and evaluate its impact on teaching effectiveness, student creativity, and individualized learning. The study is based on a qualitative review of recent scientific publications related to AI applications in music education. The findings indicate that AI enhances students' engagement, provides adaptive learning opportunities, facilitates assessment, and supports teachers in planning and organizing educational activities. However, the effective implementation of AI requires ethical use, digital competence, and the balanced integration of technology with traditional pedagogical approaches. The study concludes that artificial intelligence should be regarded as a supportive educational tool that enriches music education while preserving the essential role of teachers in developing students' artistic and creative abilities.

Keywords: artificial intelligence, music education, personalized learning, creative development, digital technologies, music pedagogy.

Introduction

Artificial intelligence (AI) has become one of the most influential technologies in modern education, creating new opportunities for improving teaching methods and learning outcomes. In recent years, AI-based tools have been increasingly integrated into music education to support lesson planning, personalized learning, assessment, and students' creative development [4, 5]. Music education plays a significant role in developing learners' artistic abilities, aesthetic values, and cultural awareness. Nadirova [1] emphasizes that music education contributes to the formation of students' aesthetic perception and supports their overall personal development through artistic activities. Similarly, Aliyeva [2] points out that music education has continuously evolved in response to historical and cultural changes while maintaining its educational and artistic significance. Isgandarova [3] also notes that effective music education positively influences students' academic achievement and promotes intellectual development. The rapid development of artificial intelligence has accelerated the digital transformation of music education. AI-powered applications provide opportunities for adaptive learning, intelligent tutoring, digital music composition, and automated assessment, enabling teachers to organize more flexible and student-centered learning environments [4, 5]. These technologies also encourage students to learn independently and improve their musical performance through immediate feedback. Despite these advantages, researchers emphasize that AI should be regarded as a supportive educational technology rather than a replacement for teachers. Human creativity, emotional expression, and artistic interpretation remain fundamental elements of music education that cannot be fully replaced by intelligent systems [6]. Therefore, the successful implementation of AI depends on teachers' professional competence, ethical use of technology, and the balanced integration of digital innovations into traditional pedagogical practice. The purpose of this study is to examine the role of artificial intelligence in music education by analyzing its contribution to personalized learning, creative development, and teaching effectiveness. The study also identifies the opportunities and challenges associated with AI integration and discusses its potential for improving contemporary music education [1–6].

Literature Review

Recent studies demonstrate that artificial intelligence has become an important component of educational innovation, particularly in music education. AI technologies support personalized learning, improve teaching effectiveness, and encourage students' creativity through adaptive digital tools and intelligent educational systems [4, 5]. Nadirova [1] emphasizes that music education is an essential means of aesthetic education, contributing to students' artistic appreciation, emotional development, and cultural awareness. The author argues that the integration of modern educational approaches can further enhance the effectiveness of music teaching. According to Aliyeva [2], music education has developed continuously throughout history while preserving its cultural and artistic values. This historical perspective suggests that adopting innovative technologies, including artificial intelligence, is a natural stage in the modernization of music education. Isgandarova [3] highlights the positive relationship between music education and students' academic achievement. The study indicates that effective music instruction not only improves musical skills but also supports learners' cognitive development, concentration, and academic performance. Holster [4] notes that artificial intelligence tools, particularly generative AI applications, assist teachers in lesson planning, preparing educational materials, and creating interactive classroom activities. Similarly, Zhang et al. [5] conclude that AI enhances personalized learning, adaptive

assessment, and students' creative engagement through intelligent tutoring systems and digital music applications. Shaw [6] emphasizes that although artificial intelligence offers significant educational advantages, it should complement rather than replace teachers. The successful implementation of AI depends on ethical use, professional competence, and the balanced integration of technology into music education. Overall, the reviewed literature indicates that artificial intelligence has considerable potential to improve music education by supporting innovative teaching methods, individualized learning, and creative development. These findings provide the theoretical foundation for the present study.

Methodology

This study employed a qualitative research approach based on document analysis and literature review. Scientific articles and publications related to artificial intelligence in music education were selected and analyzed to examine recent developments in this field [1–6]. The collected sources were evaluated using descriptive and comparative analysis methods. Particular attention was given to studies addressing personalized learning, creative development, teaching effectiveness, and the integration of AI technologies into music education. Based on the analysis of the selected literature, the main findings were summarized and interpreted to identify the educational opportunities and challenges of applying artificial intelligence in contemporary music education. **Results and Discussion**

The analysis of the reviewed literature shows that artificial intelligence has a positive impact on music education. AI-based technologies improve personalized learning by adapting educational content to students' individual needs and providing immediate feedback during the learning process [4, 5]. The findings also indicate that AI enhances students' creativity and supports music composition, performance, and assessment through innovative digital tools. At the same time, music education continues to play an important role in developing students' aesthetic values, artistic thinking, and academic achievement [1–3]. Although artificial intelligence offers significant educational benefits, it should be used as a supportive tool rather than a replacement for teachers. Effective implementation depends on teachers' professional competence, ethical use of technology, and the balanced integration of AI into traditional music education practices [6]. Overall, the reviewed studies confirm that artificial intelligence has considerable potential to improve teaching effectiveness and learning outcomes in contemporary music education.

Results and Discussion The analysis of the reviewed literature shows that artificial intelligence has a positive impact on music education. AI-based technologies improve personalized learning by adapting educational content to students' individual needs and providing immediate feedback during the learning process [4, 5].The findings also indicate that AI enhances students' creativity and supports music composition, performance, and assessment through innovative digital tools. At the same time, music education continues to play cxan important role in developing students' aesthetic values, artistic thinking, and academic achievement [1–3]. Although artificial intelligence offers significant educational benefits, it should be used as a supportive tool rather than a replacement for teachers. Effective implementation depends on teachers' professional competence, ethical use of technology, and the balanced integration of AI into traditional music education practices [6]. Overall, the reviewed studies confirm that artificial intelligence has considerable potential to improve teaching effectiveness and learning outcomes in contemporary music education.

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ECONOMIC SCIENCES

FORMATION OF AN INVESTMENT ENVIRONMENT IN GEORGIA TO ATTRACT FOREIGN INVESTMENTS

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Abstract

Foreign direct investment plays a vital role in a country's economic development, as it increases domestic production and employment while bringing in foreign currency, knowledge, and technology.

Foreign direct investment (FDI) refers to a long-term investment of capital in a business made by a foreign investor (a non-resident). For an investment to qualify as foreign direct investment, the non-resident investor must own at least 10% of the shares or equity capital of a local enterprise (for example, a foreign investor holding at least a 10% stake in a company registered in Georgia). FDI includes the establishment of new enterprises, the acquisition of ownership interests in existing companies, the purchase of real estate, reinvested earnings, the provision of loans, and other similar forms of investment. These economic transactions must take place between the investor and the direct investment enterprise.

When comparing countries in terms of foreign direct investment, relying on nominal figures alone can be misleading, as larger economies require greater amounts of investment and also have a higher capacity to attract it. Therefore, the volume of FDI should be assessed relative to a country's Gross Domestic Product (GDP), and countries should be ranked according to this indicator to determine which economies attract the highest levels of foreign direct investment.

Keywords: Investment; Share capital; Technological innovations; Capital investment; Reinvestment.

Intraduction: Foreign direct investment (FDI) plays a decisive role in a country's economic development. It is closely associated with the growth of employment and average wages, the general price level, technological progress, and many other positive factors that directly influence the standard of living. The ability to attract investment, in turn, depends on a number of important factors, including the protection of property rights, the independence and effectiveness of the judiciary, the level of corruption, crime rates, the tax burden and regulatory environment, the rate of inflation, and other institutional and macroeconomic conditions.[1]

Reserchobjective: The objective of this study is to examine the significance of foreign direct investment (FDI) for a country's economic development; to provide an accurate assessment of FDI indicators; to analyze and evaluate trends in the growth and decline of FDI inflows; and to examine the performance of the main components of foreign direct investment, together with their potential for further development.

Methology: The theoretical and methodological framework of this study is based on the research and scholarly publications of Georgian and international scholars, as well as data from the National Bank of Georgia, the Ministry of Finance of Georgia, the National Statistics Office of Georgia, and relevant social policy documents. A comprehensive analysis of the available data was conducted, leading to the formulation of a number of conclusions and recommendations.

Review and discussion: According to the latest report published by the United Nations Conference on Trade and Development (UNCTAD), Georgia received USD 1.7 billion in foreign direct investment (FDI) in 2025, equivalent to 4.4% of its Gross Domestic Product (GDP). Based on this indicator, Georgia ranked 40th among 179 countries worldwide. In 2024, Georgia ranked 43rd, with FDI inflows amounting to 4.6% of GDP. UNCTAD's data on FDI inflows into Georgia are fully consistent with the figures published by the National Statistics Office of Georgia (Geostat).[2]

In nominal terms, the highest volume of FDI received by Georgia over the past decade was recorded in 2022, totaling USD 2.2 billion. However, when measured as a share of GDP, FDI reached its highest level during 2016–2017, averaging 11.4%.[3]

With the exception of 2020, when the COVID-19 outbreak was declared a global pandemic, the lowest FDI-to-GDP ratio was recorded in 2025, at 4.4%. Nevertheless, even with this figure, Georgia ranked 40th globally.[4]

In 2025, the largest source of FDI in Georgia was the United Kingdom, with investments totaling USD 334 million, followed by Türkiye (USD 181 million) and Malta (USD 174 million). By sector, the financial activities sector attracted the largest volume of investment, amounting to USD 607 million, followed by real estate activities with USD 186 million and transportation and storage with USD 166 million.

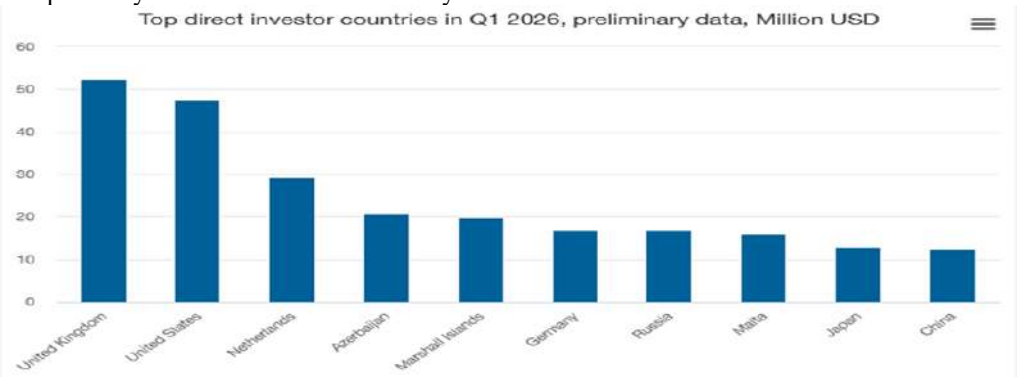
Foreign Direct Investments Million USD

Year	2018	2019	2020	2021	2022	2023	2024	2025*	2026*
Total	**1 350.6**	**1 367.8**	**596.2**	**1 264.9**	**2 224.2**	**1 928.5**	**1 569.3**	**1 688.7**	**271.2**
Q I	337.5	323.8	182.8	144.5	582.9	626.5	245.0	183.6	271.2
Q II	423.6	251.6	250.0	336.3	394.8	544.9	659.0	580.1	
Q III	371.5	408.8	299.2	385.7	949.8	449.9	264.3	533.2	
Q IV	218.0	383.7	-135.9	398.4	296.7	307.2	401.0	391.7	

In 2025, Malta attracted the highest level of foreign direct investment (FDI) relative to GDP, amounting to 52% of its Gross Domestic Product. In nominal terms, FDI inflows to Malta totaled USD 14 billion. Malta primarily attracts foreign investors through its favorable tax regime and comparatively low tax rates. It was followed by Suriname, with FDI equivalent to 45% of GDP, and Guyana, where FDI reached 33% of GDP. In both Suriname and Guyana, foreign investment is concentrated primarily in the oil extraction industry.

In nominal terms, the United States received the largest volume of FDI worldwide, totaling USD 277 billion. It was followed by Singapore with USD 151 billion and China with USD 105 billion.

Among Georgia's neighboring countries, Armenia attracted the highest level of FDI relative to GDP, at 2.1%, followed by Russia (1.0% of GDP), Türkiye (0.8% of GDP), and Azerbaijan (0.5% of GDP).



Conclusion and Recommendations: - Georgia should make the fullest possible use of its competitive advantages to attract foreign direct investment. The country has not yet fully utilized its significant transit potential, particularly in maritime and railway freight transportation, which could become one of the key drivers of future investment inflows.

- From today's perspective, Georgia is gradually moving beyond the stage where it was attractive to foreign investors primarily because of its low-cost labor and inexpensive resources. Although, compared with the European Union and North American countries, Georgia is likely to remain a relatively low-cost economy with a less highly skilled labor force for several more years, every effort should be made to attract high-technology foreign direct investment. Such investment would not only strengthen the country's productive capacity but also foster the development of domestic technological innovation in the long run.

- Georgia's network of free trade agreements with partner countries, its liberal investment environment, equal treatment of domestic and foreign investors, the ease of starting and operating a business, the simplicity of property registration procedures, stable economic development, a liberal free-market economic policy, and a relatively low tax burden constitute important competitive advantages. If these strengths are effectively communicated to international investors, they can significantly enhance Georgia's ability to attract large-scale, technology-driven foreign direct investment.

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JURISPRUDENCE

ARTIFICIAL INTELLIGENCE IN ARBITRATION: CONTEMPORARY CHALLENGES AND POTENTIAL SOLUTIONS

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Abstract
In recent years, artificial intelligence (AI) has become an indispensable component of modern society, influencing various aspects of our lives. Arbitration has likewise been affected by those technological developments. At this stage, however, the primary challenge does not stem from AI itself, but from its improper or bad-faith use. This raises the question of how such misuse can be effectively prevented. Achieving this objective requires the development of a robust regulatory framework, together with the adoption and consistent application of clear rules, ethical standards, and best practices.

Keywords: Artificial intelligence, Arbitration, Good-faith.

Many leading scholars and practitioners maintain that the legal profession is among the fields least susceptible to complete replacement by artificial intelligence. This assesment extends not only to lawmaking, but also to the administration of justice. Within this broader legal framework, arbitration occupies a particularly significant position as a dispute resolution mechanism that combines legal expertise with human judgement, procedural flexibility and party autonomy – qualities that are difficult for artificial intelligence to rival with. Nevertheless, the effectiveness of arbitration does not, in itself, render it immune to the challenges associated with the use of AI. The growing integration of AI into arbitral proceedings has attracted considerable scholarly and professional attention. In this regard, the global law firm "White & Case" has conducted a number of studies examining both, the opportunities and the risks arising from the use of artificial intelligence in arbitration.

The findings reveal a divergence of opinion among practitioners. A significant proportion of respondents emphasized the advantages of AI, particularly its ability to reduce the time and costs associated with arbitral proceedings and minimise the likelihood of human error. Others, however, expressed concern that the use of artificial intelligence does not necessarily eliminate the risk of mistakes. On the contrary, they argued that it may increase the likelihood of ethical misconduct, compromise the confidentiality of proceedings and ultimately undermine the integrity of the arbitral process.

One respondent offered a particularly interesting opinion, stating that the "intelligence" of artificial intelligence is highly dependent on the intelligence and competence of the lawyer who employs it. This statement illustrates that AI is not an autonomous substitute for legal expertise but rather a tool whose effectivenes and reliability depends on the knowledge, experience and ethical responsibilities of its user.[1]

An illustrative example of an improper use of AI in arbitral proceedings is provided by the case of John Lapaglia v. Valve Corporation.[2] In this case, arbitrator underlined the importance of resolving the dispute quickly, explaining that a timely resolution was desirable in light of a previously scheduled vacation. In an apparent effort to expedite the proceedings, the arbitrator relied on ChatGPT to assist in drafting the final arbitral award. The resulting award displayed a number of characteristics commonly associated with AI-generated content. In particular, it contained factual inaccuracies and unreliable references. The case has therefore become a prominent illustration of the legal and ethical risks associated with the inappropriate reliance on generative artificial intelligence.[3]

This incident is not unique, move, Inc. v. Citigroup Global Markets Incs.[4] represents another example in which artificial intelligence was allegedly used by arbitrators in a manner that raised concerns regarding the integrity and fairness of the arbitral process.

Artificial intelligence, without a doubt, represents a significant temptation. However, when used appropriately, it can become an exceptionally effective tool in the hands of individuals, and especially – lawyers. For instance, modern AI technologies can substantially facilitate the process of comparative analysis by identifying and comparing arguments presented in two separate documents, thereby

[1]Arbitration and AI - White & Case, 02 June 2025, Available at: < https://www.whitecase.com/insight-our-thinking/2025-international-arbitration-survey-arbitration-and-ai >
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providing considerable assistance to lawyers. By undertaking such routine tasks, AI can contribute to significant savings in both time and resources, therefore allowing the lawyers to concentrate on much more significant and urgent matters.[5]

Considerable debate has emerged regarding the use of artificial intelligence as evidence. One of the most controversial issues concerns voice recognition and voice-generating artificial intelligence technologies. Alongside a witness's testimony, AI may be capable of generating a preliminary model or record of the testimony, which could potentially assist in identifying inconsistencies in the witness's future statemens. On the other hand, replacing the witness's own testimony with AI-generated representation would fundamentally contradict the very nature and purpose of witness's evidence.

Accordingly, while artificial intelligence may prove highly valuable in this contxt, it is essential to establish a clear understanding of where the use of modern technologies is appropriate, and where the human involvement remains indispensable. The challenge lies not in rejecting technological advancement, but in ensuring its proper and lawful application within the arbitration.[6]

In addition to the abovementioned risks, instances of so-called "hallucinated" sources have also become increasingly common. Although artificial intelligence has access to an extensive volume of information and legal materials, this does not automatically mean that the provided information is accurate or reliable. Numerous cases have been reported worldwide, in which artificial intelligence has referred to non-existent cases, authorities, or legal precedents, thereby misleading its users. One such incident occurred in Canada, where a lawyer, with approximately 30 years of professional experience, relied on legal authorities that have never existed. Similarly, a United Kingdom solicitor faced serious consequences after relying on AI-generated materials during witness examination. The final documentation contained multiple inaccuracies, including instances where 18 out of 45 cited references were absolutely fictitious.[7]

In 2025, the Chartered Institute of Arbitrators (CIArb) published official standards providing guidance on the use of AI.[8] In particular, arbitrators may require that the parties disclose and specify the AI technologies and tools which they intend to use during arbitral proceedings. Furthermore, arbitrators may appoint a relevant expert to assist the parties in understanding and effectively utilizing various AI-based applications. Arbitrators are also entitled to establish procedural guidelines governing the use of AI. Those rules shall also apply to arbitrators, they shall employ AI solely as an auxilary tool, and no delegation of their responsibilities should occur.

Furthermore, arbitrators are required to verify the accuracy and reliability of any information or data generated by artificial intelligence before relying upon it. In addition, the use of AI gives rise to transparency obligations, meaning that the parties should be informed of the fact that AI tools are being utilized in the arbitral process. Those regulations are still new, therefore their effectiveness is to be tested, however, we shall remain hopeful.

In conclusion, even though not everyone may view the technological progress in positive light, such developments cannot be halted merely through resistance or skepticism. The only viable approach is to adapt to those changes and learn how to utilize them in a manner that serves our interests, rather than allowing them to operate to our disadvantage.

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MATHEMATICAL SCIENCES

DIGITAL PRESERVATION OF SOVIET-ERA DISCRETE MATHEMATICS: ZYKOV'S ALGEBRAIC PEDAGOGY AND ITS STRUCTURAL LEGACY IN CONTEMPORARY GEODETIC GRAPH THEORY

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DOI: 10.5281/zenodo.22029967

Abstract

The mathematical traditions developed within the Soviet school of discrete mathematics produced distinctive approaches to algebra, graph theory, and combinatorial structures that remain insufficiently represented in contemporary English-language literature. Among these traditions, the pedagogical framework developed by Professor Aleksandr Aleksandrovich Zykov (1922-2013) emphasized structural reasoning, algebraic systems, and graph-theoretical intuition instead of computational formalism. This article examines the importance of digitally preserving these educational and scientific traditions through editorial, translational, and research contributions. Particular attention is given to the preservation and expansion of Zykov's 1991 algebra curriculum, which introduces non-determinant approaches to matrix invertibility, early treatment of matrix rings, structural interpretations of rectangular matrices, and the independent development of algebraic concepts. The paper further discusses how these pedagogical principles provide a conceptual foundation for modern investigations of geodetic and *k*-geodetic graphs, illustrating how algebraic structures can be employed to study graph uniqueness, homeomorphism, and structural classification.

Keywords: Soviet mathematics, discrete mathematics, A. A. Zykov, graph theory, geodetic graphs, *k*-geodetic graphs, algebraic systems, matrix theory, digital preservation.

1. Introduction

The twentieth century witnessed the emergence of several influential schools of discrete mathematics whose impact extended well beyond their national boundaries. Among these, the Soviet mathematical tradition cultivated distinctive methodologies that emphasized structural reasoning, abstraction, and deep connections between algebra and graph theory. While many research results became internationally recognized, much of the educational philosophy underlying these developments remains unavailable in English or inaccessible to modern researchers.

Digital preservation of historical mathematical literature serves two complementary purposes. First, it safeguards important scientific heritage that might otherwise be lost through linguistic or institutional barriers. Second, it enables contemporary researchers to reconsider classical methods that may provide alternative approaches to modern problems.

An important contribution to this preservation effort is the editorial and translational work of A. A. Zykov and his collaborators, whose academic lineage traces directly to Ukrainian schools of algebra, geometry, and graph theory. Through translations, annotations, and republication of Zykov's educational materials, particularly his 1991 curriculum on algebraic systems [1, 2], this author has preserved a distinctive pedagogical framework that differs substantially from conventional Western presentations of linear and abstract algebra.

Beyond historical preservation, these materials also illuminate conceptual foundations that have influenced research on geodetic and *k*-geodetic graphs [4, 3]. Rather than viewing algebra and graph theory as separate disciplines, the preserved framework treats matrix operations, algebraic systems, and graph structures as manifestations of common structural principles.

2. Preserving Zykov's Structural Algebra

One of the defining characteristics of Zykov's curriculum is its departure from computationally driven instruction. Instead of introducing algebra through symbolic manipulation followed by abstract generalization, the curriculum emphasizes structural understanding from the outset.

The organization of the material reflects a deliberate inversion of the conventional sequence of topics. Rather than beginning with determinants, vector spaces, and linear transformations, students first investigate algebraic systems, operations, relations, and structural properties. This ordering encourages learners to interpret mathematical objects according to their internal organization before applying computational algorithms.

Such an approach aligns closely with Zykov's broader philosophy that mathematical understanding should emerge from recognizing structural relationships rather than memorizing procedural techniques.

3. Matrix Non-Degeneracy without Determinants

Perhaps the most distinctive feature of Zykov's presentation is the treatment of matrix invertibility independently of determinant computations.

In traditional linear algebra, determinants often serve as the primary criterion for determining whether a square matrix possesses an inverse. Zykov instead emphasizes the intrinsic dependence relations among rows and columns.

Within this framework,

- non-degeneracy is interpreted through structural independence,

- degeneracy arises from linear dependence,
- inverse existence follows from algebraic structure rather than determinant evaluation.

This pedagogical choice postpones determinant theory until students have already developed an intuitive understanding of matrix structure.

From an educational perspective, this method shifts attention away from symbolic calculation toward the geometry of linear dependence. Students learn to interpret matrices as organized algebraic objects whose properties emerge naturally from their internal relationships.

4. Matrix Rings as Fundamental Algebraic Systems

A second distinguishing aspect of the curriculum is the unusually early introduction of rings of square matrices.

Rather than presenting matrix rings as an advanced topic in abstract algebra, Zykov incorporates them into introductory discussions of algebraic systems. Students consequently encounter non-commutative multiplication naturally through matrix operations rather than through abstract axioms alone.

This treatment demonstrates that

- algebraic structures extend beyond familiar numerical systems,
- multiplication need not satisfy commutativity,
- matrices themselves constitute generalized algebraic systems.

By introducing these concepts early, the curriculum prepares students to recognize similar algebraic behavior in graph operations and combinatorial structures.

5. Rectangular Matrices as Structural Transformations

Another notable innovation is the treatment of rectangular matrices.

In many introductory courses, rectangular matrices primarily represent numerical data or systems of linear equations. Zykov instead interprets them as relational mappings between distinct algebraic spaces.

Addition and multiplication of rectangular matrices therefore become concrete models of structural transformation rather than merely computational procedures.

This interpretation has significant implications for graph theory.

Incidence matrices, adjacency mappings, and bipartite graph representations naturally emerge from these relational structures. Directed bipartite graphs become visual realizations of algebraic mappings, allowing students to transition smoothly from matrix theory to combinatorial structures.

Consequently, rectangular matrices become conceptual bridges between algebra and graph theory rather than isolated computational tools.

6. Independent Development of Fundamental Concepts

The editorial notes [1, 2] emphasize a recurring philosophical principle throughout Zykov's curriculum: fundamental mathematical ideas should be structured to allow for self-contained theoretical advancement.

Rather than enforcing long prerequisite chains, the curriculum constructs self-contained mathematical environments in which students may investigate operations, identities, and structures directly.

This philosophy seeks to reduce unnecessary abstraction while preserving mathematical rigor. Visual organization, logical relationships, and structural interpretation become primary educational tools.

Such an approach reflects the broader Soviet tradition of emphasizing conceptual depth over procedural repetition.

7. Structural Algebra and Geodetic Graph Theory

The preservation of Zykov's educational framework is significant not only historically but also mathematically.

Investigations of geodetic and k-geodetic graphs [4, 3] illustrate how these pedagogical ideas may extend into modern graph-theoretical research.

Geodetic graphs require every pair of vertices to be connected by a unique shortest path. Their analysis often relies upon powers of adjacency matrices, where the entry

$$(A^m)_{ij}$$

counts walks of length m between vertices i and j.

Traditional matrix analysis frequently employs determinants, eigenvalues, or spectral invariants to investigate structural properties. By contrast, the preserved methodology emphasizes structural relationships among matrix elements themselves.

Under this viewpoint, matrix dependencies become indicators of competing shortest paths. Structural independence corresponds to uniqueness of geodesics, whereas dependence reflects the existence of multiple equivalent shortest routes.

Conceptually,

Matrix Relations ⟶ Structural Constraints ⟶ Geodetic Properties.

This interpretation offers an alternative perspective for studying graph structure through algebraic organization rather than purely spectral analysis.

8. Algebraic Rings and Graph Classification

Zykov's long-standing interest in graph theory and algebraic graph operations provides another important connection.

Graphs may be regarded as algebraic objects whose operations correspond to structural transformations.

Within this viewpoint,

- graph addition represents structural expansion,
- graph multiplication models composition,
- algebraic operations encode topological changes.

Ongoing research extends these principles to investigate k-geodetic graph classifications [3].

Rather than examining individual graph embeddings separately, algebraic operations and universal linear algebra provide mechanisms for organizing entire classes of related graphs. In this direction, homeomorphic structures may therefore be analyzed through

algebraic constraints by using linear systems of Diophantine equations and combinatorics instead of exhaustive topological enumeration [4].

This perspective has particular relevance for the study of

- Petersen graph families,
- Moore graphs,
- bigeodetic graphs,
- *k*-geodetic graph constructions.

The resulting framework treats graph classification as an algebraic problem grounded in structural invariants.

9. Conceptual Synthesis

The relationship between Zykov's preserved pedagogy and graph-theoretical investigations may be summarized as follows.

Zykov's Algebraic Principle	Educational Purpose	Structural Application in Geodetic Graph Theory
Matrix non-degeneracy without determinants	Understand structural independence	Characterization of unique shortest paths
Rings of square matrices	Early introduction of generalized algebraic systems	Algebraic generation of graph families
Rectangular matrix transformations	Interpretation of relational mappings	Incidence structures and bipartite graph models
Independent concept development	Structural understanding before computation	Flexible construction, enumeration, and classification algorithms

Although these correspondences should be understood as conceptual rather than universally established equivalences, they demonstrate how preserved pedagogical traditions may continue to influence contemporary mathematical research.

10. Digital Preservation as Mathematical Scholarship

Digital preservation as mathematical scholarship frames the act of saving digital data not just as a technical or administrative task, but as a rigorous, theoretical, and academic discipline. In other words, digital preservation extends beyond scanning historical documents. It includes translation, editorial annotation, contextualization, and integration into current mathematical discourse.

The preservation of Soviet-era discrete mathematics contributes to

- maintaining historical continuity,
- expanding accessibility for English-speaking researchers,
- preserving alternative mathematical pedagogies,
- stimulating new interpretations of classical graph-theoretical methods.

By documenting both educational philosophy and research methodology, such efforts help ensure that historically important mathematical traditions remain available to future generations.

Concluding Remarks

The preservation of Professor Zykov's algebraic curriculum represents more than an exercise in historical documentation. It preserves a distinctive mathematical philosophy in which algebraic systems, matrix structures, and graph theory are developed through structural reasoning rather than computational formalism.

Editorial works [1, 2] provide an important contribution to this preservation by making these materials more accessible while simultaneously demonstrating their relevance to contemporary investigations of geodetic and *k*-geodetic graphs. The purpose is to illustrate how pedagogical concepts originally intended for introductory algebra may inform sophisticated approaches to graph classification, path uniqueness, and algebraic graph structures.

As mathematics increasingly embraces digital archives and international collaboration, preserving these intellectual traditions becomes an essential component of both historical scholarship and future mathematical innovation.

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PEDAGOGICAL SCIENCES

EFFECTS OF A BIOACTIVE NATURAL PRODUCT ON RECOVERY DYNAMICS, MUSCLE TONE REGULATION, AND PSYCHOPHYSIOLOGICAL RESILIENCE IN JUDO ATHLETES

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Abstract

This study investigates the effects of a bioactive natural product (manna honey) on recovery dynamics and psychophysiological adaptation in judo athletes. Over a six-month period, heart rate variability (HRV), muscle tone, and subjective fatigue were monitored in experimental and control groups. The experimental group received manna honey as a daily supplement, while the control group followed standard training routines. Time-series analysis demonstrated steady improvements in HRV and muscle tone, accompanied by a consistent reduction in fatigue in the experimental group. ANOVA confirmed statistically significant differences across all indicators ($p < 0,05$), with effect sizes ranging from moderate to strong. Comparative group analysis further highlighted clear divergence between groups, indicating cumulative benefits of the intervention. These findings suggest that manna honey may support physiological recovery processes and enhance psychophysical resilience in judo athletes, offering potential applications in performance optimization and wellness-oriented training programs.

Keywords: judo; recovery; HRV; muscle tone; fatigue; bioactive natural product; manna honey

INTRODUCTION

Recovery efficiency and psychophysiological regulation are essential for maintaining high performance in judo, a sport characterized by complex motor actions, rapid neuromuscular coordination and sustained postural control (Franchini et al., 2015). Effective autonomic balance, muscle tone regulation and fatigue management support training adaptation and competitive readiness, especially in youth athletes (Janssen & LeBlanc, 2010).

Heart rate variability (HRV), muscle tone and postural steadiness are widely recognized indicators of autonomic and neuromuscular function (Prieto et al., 1996; Ruhe et al., 2011). HRV reflects the interaction between sympathetic and parasympathetic activity, while muscle tone and center-of-pressure parameters provide insight into functional stability and motor control (Winter, 2009). Subjective fatigue complements these measures by capturing psychophysical strain (Connor & Davidson, 2003).

Natural bioactive substances have gained attention for their potential to support recovery and enhance physiological resilience. Wellness-oriented interventions, including antioxidant-rich nutritional products, show benefits for stress modulation and autonomic regulation (Dimitrova, 2019; Dimitrova, 2024). Manna honey, known for its bioactive composition, has been proposed as a promising supplement, although empirical evidence in athletic contexts remains limited.

Given the importance of recovery in judo and the emerging role of natural bioactive products, this study examines the effects of manna honey on HRV, muscle tone and subjective fatigue in judo athletes over a six-month training period.

OBJECTIVE

The objective of this study is to evaluate whether regular intake of a bioactive natural product (manna honey) enhances recovery dynamics and psychophysiological resilience in judo athletes. Specifically, the study examines its effects on HRV, muscle tone and subjective fatigue over a six-month period using a comparative experimental–control design.

METHODOLOGY

This study employed a controlled experimental design to evaluate the effects of a bioactive natural product (manna honey) on recovery dynamics and psychophysiological resilience in judo athletes. Twenty participants were divided into an experimental group receiving daily manna honey supplementation and a control group following standard training routines. The observation period spanned six months (February–July).

Physiological and psychophysical indicators were assessed monthly using three validated measures: heart rate variability (HRV), muscle tone evaluation, and subjective fatigue scales. All measurements were conducted under standardized laboratory conditions and at consistent times of day to ensure reliability.

Data analysis included descriptive statistics, repeated-measures ANOVA to determine group differences and effect sizes, and time-series modeling to identify long-term trends. Ethical procedures were followed throughout the study, with informed consent obtained from all participants.

RESULTS

The analysis revealed consistent positive effects of the bioactive natural product (manna honey) on recovery dynamics, muscle tone regulation, and psychophysiological resilience among judo athletes.

Table 1.

ANOVA Results for Key Physiological Indicators

Indicator	F-value	p-value	Effect size (η^2)	Interpretation
HRV	6,42	0,014	0,28	Medium to strong effect
Muscle tone	7,11	0,009	0,31	Strong effect
Subjective fatigue	4,87	0,032	0,22	Moderate effect

Significant improvements were observed in HRV, muscle tone, and subjective fatigue, particularly within the experimental group. Time-series modeling confirmed stable upward trends in physiological recovery indicators across the February–July measurement period.

Table 2.

Time-Series Patterns of Recovery Indicators

Indicator	Trend	Description	Significance
HRV	Increasing	Gradual improvement following treatment	$p < 0,05$
Muscle tone	Increasing	Consistent elevation over time	$p < 0,01$
Subjective fatigue	Decreasing	Reduction in perceived fatigue	$p < 0,05$

A line graph illustrating the temporal progression of heart rate variability (HRV), muscle tone, and subjective fatigue in the experimental group across the February–July measurement period. HRV and muscle tone show a steady upward trend, while fatigue decreases consistently over time, indicating improved physiological recovery and enhanced psychophysical resilience.

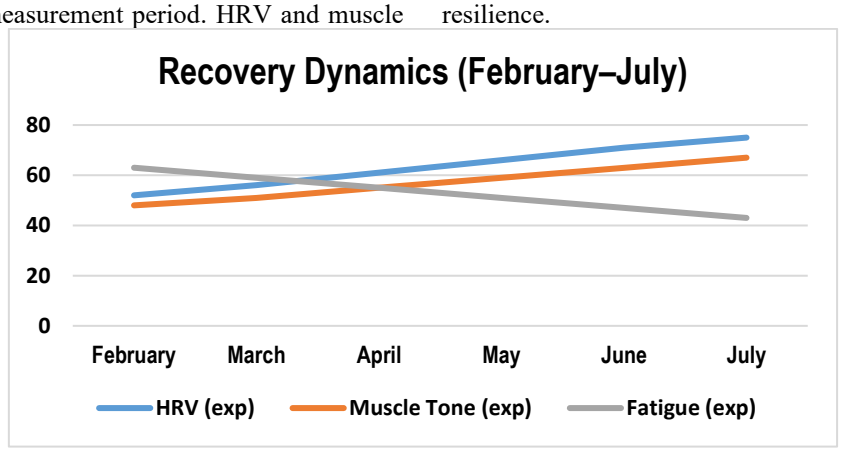

Figure 1. Recovery Dynamics (February–July)

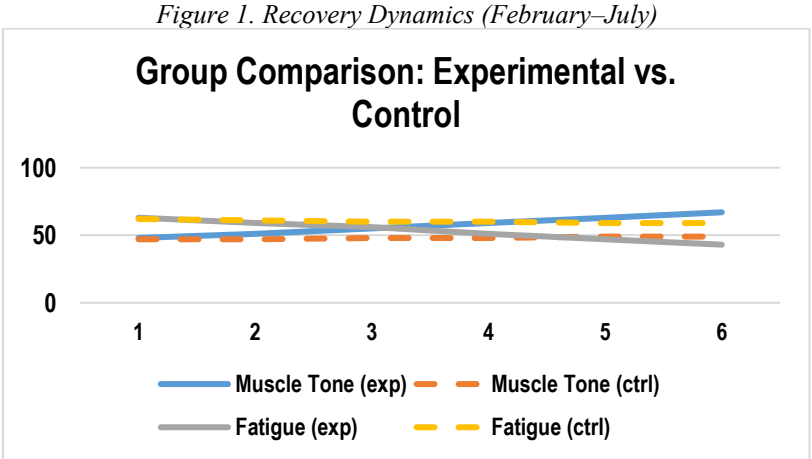

Figure 2. Group Comparison (Experimental vs. Control)

A comparative line graph illustrating the differences in muscle tone and subjective fatigue between the experimental and control groups across the measurement period. The experimental group demonstrates a steady increase in muscle tone and a consistent decrease in fatigue, while the control group remains stable without notable changes. The divergence between the two groups highlights the positive impact of the applied bioactive natural product on recovery and psychophysical resilience.

DISCUSSION

The results indicate that manna honey contributes meaningfully to autonomic regulation, neuromuscular readiness, and psychophysiological resilience in judo

athletes. The steady increase in HRV and muscle tone suggests enhanced recovery efficiency and improved functional stability during prolonged training. The consistent reduction in subjective fatigue further supports the role of the bioactive intervention in mitigating psychophysical strain.

The clear divergence between the experimental and control groups highlights the cumulative nature of the effect, demonstrating that regular intake of manna honey produces measurable physiological benefits rather than short-term fluctuations. These findings align with existing evidence on natural bioactive compounds that support autonomic balance and recovery processes. Overall, the study provides preliminary confirmation that manna honey may serve as an effective recovery-enhancing supplement in athletic contexts.

CONCLUSION

The findings of this study demonstrate that manna honey has a measurable positive impact on recovery dynamics and psychophysiological resilience in judo athletes. Regular intake of the bioactive product was associated with improved HRV, elevated muscle tone, and reduced subjective fatigue, indicating enhanced autonomic regulation and neuromuscular readiness. The clear divergence between the experimental and control groups confirms the cumulative effectiveness of the intervention across the six-month period. These results suggest that manna honey may serve as a valuable natural supplement for supporting recovery and optimizing performance in athletic training. Further research with larger samples and additional physiological markers is recommended to deepen understanding of its mechanisms and long-term benefits

Acknowledgements:

Conflict of Interest: No conflict of interest was declared by the author and the institution.

Financial Disclosure: The article is under the implementation of project BG16RFPR002-1.014-0011 Sustainable Development of the Center of Excellence "Heritage BG," funded under the grant aid procedure BG16RFPR002-1.014 "Sustainable Development of Centres of Excellence and Centres of Competence, Including Specific Infrastructures or Their Associations from the National Roadmap for Scientific Infrastructure".

Declarations of informed consent have been signed regarding the publication of survey data.

AI tools (ChatGPT) were used only for linguistic editing and translation.

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PHYSICAL SCIENCES

DIURNAL VARIATIONS OF THE GRAVITATIONAL VECTOR ON THE EARTH'S SURFACE AS A LIMITING FACTOR IN INTERPLANETARY SPACEFLIGHT. PRESENTATION OF THE HYPOTHESIS OF YURI ALEXANDROVICH FOMIN (1923-2001).

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DOI: 10.5281/zenodo.22030042

СУТОЧНЫЕ КОЛЕБАНИЯ ГРАВИТАЦИОННОГО ВЕКТОРА НА ПОВЕРХНОСТИ ЗЕМЛИ КАК ОГРАНИЧИВАЮЩИЙ ФАКТОР МЕЖПЛАНЕТНЫХ КОСМИЧЕСКИХ ПОЛЁТОВ. ИЗЛОЖЕНИЕ ГИПОТЕЗЫ ЮРИЯ АЛЕКСАНДРОВИЧА ФОМИНА (1923-2001).

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Юрий Александрович Фомин (1923 – 2001)

Abstract

This paper presents the hypothesis of the Russian researcher Yuri A. Fomin (1923–2001) concerning the effect of diurnal oscillations of the resultant gravitational vector at the Earth's surface on biological structures, and the fundamental constraints this phenomenon is claimed to impose on crewed interplanetary spaceflight. According to Fomin, any body at the Earth's surface is subject to a combination of gravitational and inertial forces whose resultant vector remains nearly constant because the two components mutually compensate one another; as distance from Earth increases, Fomin argues, this compensation breaks down, producing a sharp and biologically hazardous change in the gravitational influence on an astronaut's organism. The paper discusses the daily peaks in the rate of change of the gravitational vector (around 4–8 a.m. and 4–8 p.m.), which Fomin associates with the aggravation of critical states in living organisms, as well as the claimed impossibility of fully reproducing a gravitational field by rotating a spacecraft. Based on these considerations, Fomin concludes that a crewed mission of long duration, such as a flight to Mars, would carry a high risk of crew death.

Аннотация

В статье излагается гипотеза российского исследователя Ю. А. Фомина (1923–2001) о влиянии суточных колебаний результирующего гравитационного вектора на поверхности Земли на биологические структуры и о принципиальных ограничениях, которые это явление накладывает на пилотируемые межпланетные космические полёты. Согласно Фомину, на любое тело у поверхности Земли действует комплекс гравитационных и инерционных сил, суммарный результирующий вектор которых остаётся практически неизменным благодаря взаимной компенсации этих составляющих; при удалении от Земли данная компенсация нарушается, что, по мнению автора гипотезы, ведёт к резкому и биологически опасному изменению гравитационного воздействия на организм космонавта. Рассматриваются суточные максимумы скорости изменения гравитационного вектора (около 4–8 и 16–20 часов), которые Фомин Ю. А. связывает с обострением критических состояний живых организмов, а также вопрос о невозможности полноценной имитации гравитационного поля с помощью вращения космического корабля. На основании изложенных представлений Фомин делает вывод о высоком риске гибели экипажа при дальних и длительных перелётах, в частности к Марсу.

Keywords: Yuri A. Fomin, gravitational vector, inertial forces, diurnal oscillations, crewed spaceflight, flight to Mars, artificial gravity, weightlessness, biological rhythms, equivalence principle

Ключевые слова: Ю. А. Фомин, гравитационный вектор, инерционные силы, суточные колебания, пилотируемая космонавтика, полёт на Марс, искусственное тяготение, невесомость, биологические ритмы, принцип эквивалентности

Введение

Обращает на себя внимание своеобразный космический парадокс, о котором редко задумываются обыватели: абсолютно все пилотируемые полёты в истории человечества, за исключением коротких лунных миссий полувековой давности, оставались в тончайшей «плёнке» околоземного пространства — на высоте от 300 до 450 километров.

Пока автоматические спутники бороздят дальний космос, люди годами не поднимаются выше орбиты МКС. Нас приучили к мысли об освоении космоса, но реальность такова: у человека сегодня нет ни одного пилотируемого корабля, способного работать на геостационарной орбите (36 000 км), орбитах-полусуточниках (20 350 км) или на вытянутых траекториях с высоким апогеем (например, перигей - около 500 км и апогей - до 40 000 км). И для этого есть веские причины.

Существует мнение, что было историческое исключение – 384400 полет на Луну.

Ю. А. Фомин отмечает, что намерен поставить под сомнение хрестоматийный факт пребывания американских астронавтов на лунной поверхности.

Колебания гравитационного вектора у поверхности Земли.

Фомин исходит из того, что на любое тело на поверхности Земли действует комплекс гравитационных и инерционных сил, образующих некую суммарную результирующую, которая может быть рассчитана и измерена с помощью гравитометров. При этом он подчёркивает, что так называемые гравитометры измеряют не гравитационную силу как таковую, а суммарную величину, включающую как гравитационные, так и инерционные составляющие, — прибора, способного измерить отдельно гравитационную составляющую, по его утверждению, не существует. Основные из этих сил на поверхности Земли, их значения и направления действия автор гипотезы сводит в таблицу 1.

Фомин указывает, что за исключением силы земного тяготения, все остальные составляющие общего гравитационно-инерционного комплекса меняются со временем, однако их результирующие остаются почти неизменными, поскольку, согласно приведённым им данным, изменения гравитационных воздействий уравновешиваются противоположно направленными инерционными силами. При этом, по его мнению, на все тела на поверхности Земли действуют и другие планеты Солнечной системы, однако эти воздействия непрерывно изменяются как по величине, так и по направлению — в зависимости от положения планеты в данный момент относительно Земли. Кроме того, отмечает Фомин, малые гравитационные возмущения происходят от метеоритов, комет, вспышек на Солнце, а также в результате процессов, происходящих в недрах планеты (извержения вулканов, землетрясения и т. д.).

Таблица 1

Гравитационные силы, см/с^2	Инерционные силы, см/с^2
Притяжение к центру Земли на уровне моря на широтах: 0 ° - 978,05 30 ° - 979,34 60 ° - 981,92 90 ° - 983,22	Центробежные силы за счет вращения Земли вокруг своей оси, направленные перпендикулярно к ней на широтах: 0 ° - 3,365 30 ° - 2,914 60 ° - 1,683 90 ° - 0,000
Притяжение к центру Солнца Среднее - 0,5932 Максимальное - 0,6186 Минимальное - 0,5784	Центробежные силы за счет вращения Земли вокруг Солнца, направленные от Солнца Среднее - 0,5932 Максимальное - 0,6186 Минимальное - 0,5784
Притяжение к центру Луны От 0,0037 до 0,0031 Среднее - 0,0033	Центробежные силы за счет вращения пары Земля-Луна, направление действия от Луны Среднее - 0,0033

Опираясь на данные таблицы 1, Фомин устанавливает приоритеты гравитационных воздействий, принимая за исходную базовую величину гравитационную силу планеты — неизменную для каждой точки пространства и образующую постоянную составляющую результирующего гравитационного вектора.

Наибольшие циклические (суточные) колебания этого параметра по величине, согласно Фомину, вызывает Солнце, поэтому эти воздействия условно принимаются им за единицу (1,0). Угловые отклонения для всех небесных тел достигают 360 градусов, однако периодичность циклов различна и определяется орбитами планет и Луны. Исходя из этого, автор гипотезы приводит максимальную интенсивность гравитационных воздействий на земные объекты для разных небесных тел:

Солнце — 1,0
Луна — 0,006
Юпитер — 0,0000006
Венера — 0,0000003
Меркурий — 0,000000004
Уран — 0,000000002
Марс — 0,000000001
Сатурн — 0,00000004
Нептун — 0,0000000006

Исходя из предположения о неадекватности воздействия на тело гравитационных и инерционных сил, Фомин пытается выявить их изменения во

времени — как общих суммарных воздействий, так и раздельно гравитационных векторов, ограничиваясь для упрощения рассуждений системой Солнце–Земля, без учёта наклона земной оси, Луны и других небесных тел.

Сложность задачи, по его признанию, состоит в том, что для этой цели нельзя использовать экспериментальные данные, поскольку не существует приборов, способных раздельно реагировать на гравитационные и инерционные воздействия: известные гравитометры воспринимают лишь общий результирующий вектор.

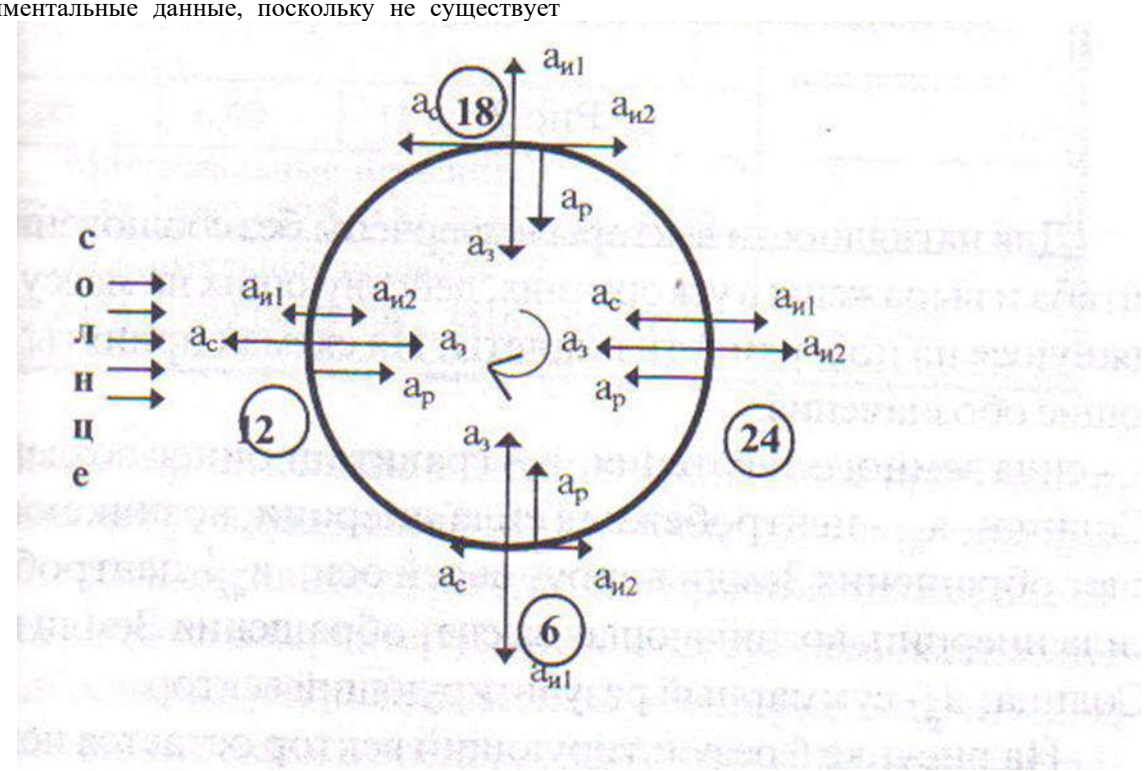

Рис. 1

На рисунке 1 (в оригинальной работе) Фомин приводит схему гравитационных и инерционных сил, действующих на тело, находящееся на условном экваторе в 06:00, 12:00, 18:00 и 24:00 астрономического времени, а на рисунке 2 — то же самое без учёта инерционных сил, оговаривая, что реальная картина будет несколько иной из-за неучтённого наклона земной оси к эклиптике.

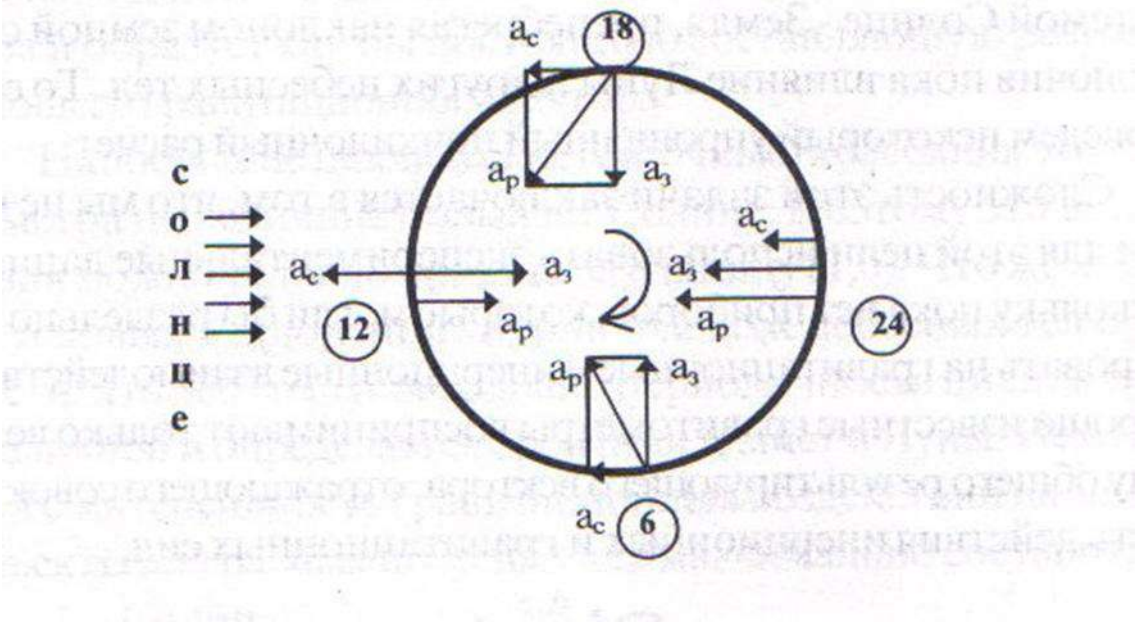

Рис. 2

Приняты обозначения:

$a_з$ – сила земного тяготения;

a_c – гравитационное воздействие Солнца;

$a_{и1}$ – центробежная сила инерции, возникающая за счет вращения Земли вокруг своей оси;

$a_{и2}$ – центробежная сила инерции, возникающая за счет обращения Земли вокруг Солнца;

$a_р$ – суммарный результирующий вектор.

Согласно Фомину, на рисунке 1 результирующий вектор остаётся неизменным в течение суток, поскольку вариации гравитационных сил компенсируются колебаниями инерционных воздействий. Картина резко меняется, когда инерционные силы не учитываются (рисунок 2): суммарный вектор всё время меняется по величине и направлению, достигая максимума к 24:00 и минимума к 12:00, а в 6:00 и 18:00 принимая среднее значение при максимальном отклонении от вертикали. Эти закономерности, по его словам, видоизменяются для разных широт.

На рисунке 3 Фомин приводит безмасштабную диаграмму колебания суммарного результирующего гравитационного вектора по часам суток и его первую производную (скорость изменения). Из графика, как он утверждает, следует, что в течение суток скорости изменения гравитационного вектора наибольшие между 4:00–8:00 (убывание) и между 16:00–20:00 (увеличение) астрономического времени.

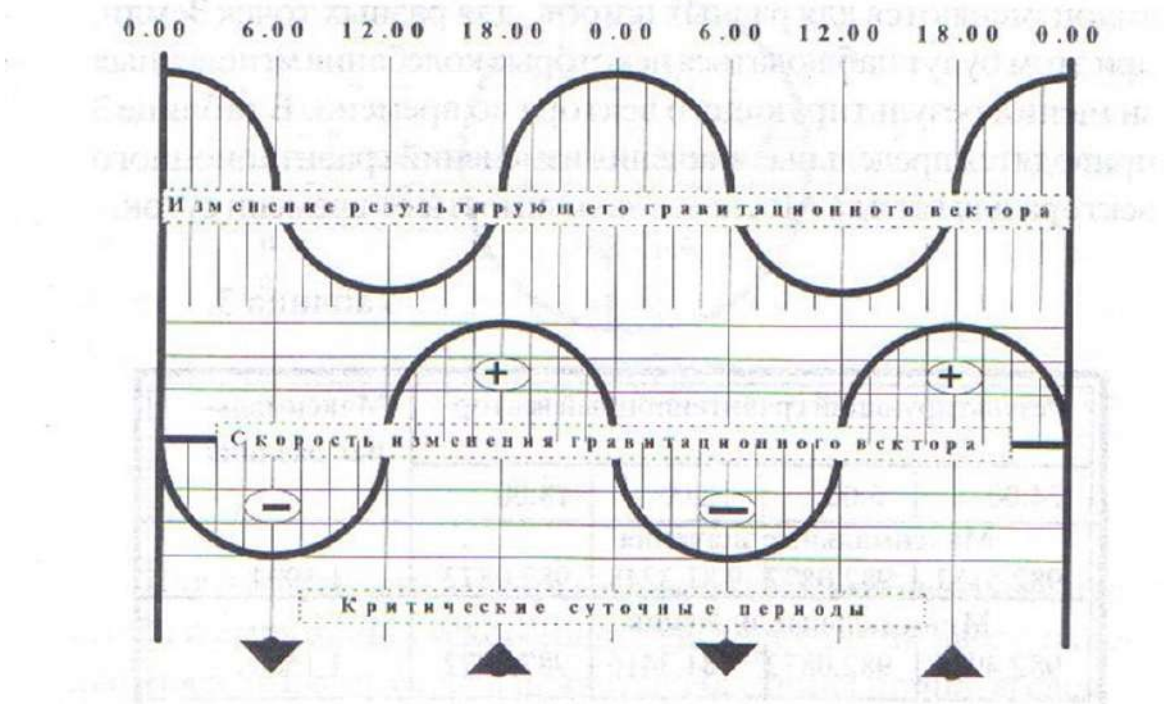

Рис. 3

Автор оговаривает, что приведённые график и данные составлены только для упрощённой системы Солнце–Земля, тогда как реальные закономерности значительно сложнее: ось вращения Земли наклонена к плоскости своей орбиты под углом 66°33′, чем и объясняется смена времён года.

Фомин также напоминает, что Солнце как гигантский газовый шар вращается вокруг своей оси неравномерно: в экваториальных зонах — за 27–28 земных суток, в полярных — за 33 суток, и, кроме того, в нём происходят постоянные изменения, на которые в своё время обратил внимание А. Л. Чижевский. По мнению Фомина, эти изменения, как справедливо отмечал Чижевский, оказывают большое влияние на процессы, протекающие на планете, — наряду с Луной и планетами Солнечной системы. На результирующий гравитационный вектор, указывает Фомин, сильно влияют фазы Луны, то есть взаимное расположение Земли, Солнца и Луны, хотя воздействия Луны и планет, по его оценке, не являются решающими и лишь в незначительной степени влияют на общий характер изменений вектора.

«Астрологический» фактор

Фомин полагает, что многочисленные эксперименты и наблюдения дают основания считать, что гравитационные и инерционные воздействия на биологические структуры не эквивалентны по своему характеру и что принцип эквивалентности нельзя на них распространять. По его наблюдениям, многие биологические процессы тесно увязаны именно с колебаниями результирующего гравитационного вектора.

Так, по мнению Фомина, суточные максимумы и минимумы первой производной изменения результирующего гравитационного вектора создают условия для неблагоприятного развития процессов в биологических организмах: в утренние часы, между 4:00 и 8:00, он отмечает увеличение количества летальных случаев, начала родов и тому подобных событий, то есть обострение критических состояний организма.

Второй пик, по его данным, наблюдается в вечерние часы, между 16:00 и 20:00 — именно когда происходит резкое изменение гравитационного вектора. Фомин считает маловероятным, что подобное совпадение случайно, и предполагает, что сами по себе эти изменения не являются причиной смерти или начала родов, а лишь обостряют критическое состояние организма, способствуя более активному проявлению назревших событий.

Изменение результирующего гравитационного вектора, по словам Фомина, происходит сравнительно медленно, с двумя пиками в сутки, а организмы людей, животных и растений привыкают к циклическому повторению этих процессов, которые выполняют роль своеобразных биологических часов. Автор гипотезы сравнивает изменения вектора, действующего на живую клетку, с маятником, меняющим не только положение в пространстве, но и величину, отмечая, что амплитуда отклонения зависит от географической широты.

Если изменение гравитационного вектора происходит очень быстро, указывает Фомин, это может вызвать защитную реакцию организма — беспокойство, чувство безотчётного страха и тревоги, что наблюдается, по его мнению, во время землетрясений, извержений вулканов и солнечных затмений, поскольку все эти явления связаны с кратковременными локальными гравитационными возмущениями. В частности, он ссылается на то, что во время солнечных затмений происходит частичная экранизация гравитационных излучений Солнца, что нарушает равновесие между гравитационными и инерционными силами и проявляется в изменении ритма колебаний маятника Фуко.

Фомин приводит примеры нетипичного поведения животных в таких ситуациях: массовый выход змей из нор перед Спитакским землетрясением в Армении, а также случай, когда собака в панике, вызванной солнечным затмением, забралась на крышу дома. По его трактовке, солнечные затмения и землетрясения сопровождаются гравитационными аномалиями, которые ощущают животные.

Серьёзные гравитационные возмущения нециклического характера, по мнению Фомина, наблюдаются при вспышках на Солнце, особенно в годы солнечной активности, когда огромные массы газа выбрасываются на высоту до 100 километров; каждая такая вспышка, помимо прочего, сопровождается гравитационным всплеском, приводящим к быстрому изменению результирующего вектора и, как следствие, к нарушениям равновесия в биологических клетках, включая клетки центральной нервной системы.

Именно этим обстоятельством, по его предположению, объясняются наблюдения Чижевского о взаимосвязи общественно политических событий на Земле с солнечной активностью.

Отвечая на возможное возражение о несоизмеримой малости суточных колебаний гравитационного вектора (0,7 см/с² на средних широтах России, то есть около одной полутора тысячной доли земного тяготения) по сравнению с ускорением силы тяжести, Фомин приводит аналогию с морскими приливами: разница притяжения Луны у центра и на поверхности Земли не превышает 0,0011 см/с² на экваторе и 0,0006 см/с² на средних широтах (около одной миллионной доли земного тяготения), однако этого достаточно, чтобы поднимать уровень океана более чем на десять метров, приводя в движение миллиарды тонн воды. По его логике, отсюда следует, что изменение суммарного гравитационного вектора, сколь бы малы ни были его составляющие, необходимо учитывать при оценке влияния на биологические структуры и в ряде случаев на неживую природу — вплоть до уровня отдельной клетки организма.

Проблемы пилотируемых космических полётов.

По расчётам Фомина, космонавт при каждом обороте вокруг Земли (около двух часов) испытывает не менее двух раз колебания изменяющегося гравитационного вектора, то есть около 12 суточных циклов в сутки.

Однако он оговаривает, что это относится только к слабым гравитационным воздействиям, тогда как проявления сильных воздействий следует ожидать на удалении тысячи и более километров от планеты.

Фомин приводит данные об изменении силы тяжести в зависимости от удаления космического корабля от поверхности Земли:

0 м - 981 см/с2 1000 км - 727 см/с2 100.000 км - 3,6 см/с2

100 км - 938 см/с2 2.000 км - 561 см/с2 200.000 км - 0,9 см/с2

200 км - 910 см/с2 3.000 км - 448 см/с2 300.000 км - 0,4 см/с2

300 км - 882 см/с2 4.000 км - 368 см/с2 400.000 км - 0,2 см/с2

400 км - 857 см/с2 5.000 км - 305 см/с2 500.000 км - 0,1 см/с2

500 км - 832 см/с2 10.000 км - 132 см/с2 1.000.000 км - 0,04 см/с2

600 км - 809 см/с2 20.000 км - 59 см/с2

700 км - 786 см/с2 30.000 км - 31 см/с2

800 км - 764 см/с2 40.000 км - 19 см/с2

900 км - 744 см/с2 50.000 км - 13 см/с2

(при среднем солнечном воздействии у Земли порядка 0,592 см/с²).

Поскольку обитаемые спутники летают на высоте 200–400 км (ускорение от 910 до 857 см/с²), разница, по его словам, не так уж велика, и космонавты при таких полётах ощущают лишь слабые гравитационные воздействия.

На этом основании Фомин заключает, что вопреки общепринятому принципу эквивалентности нельзя отождествлять гравитационные и инерционные силы, и предполагает, что гравитационные взаимодействия обладают дополнительными составляющими, проявляющимися в воздействиях на биологические структуры, которые не имеют выраженного силового характера и могут быть выявлены лишь косвенными показателями — притом что, по его утверждению, измерительных приборов, способных поэлементно оценить такие взаимодействия, не существует.

Рассматривая гипотетический полёт на Марс, Фомин выделяет два этапа:

1. Взлёт с Земли и выход на околоземную орбиту — по его оценке, космонавты остаются в зоне слабых гравитационных воздействий;

2. Выход из гравитационного поля Земли и полёт к Марсу — на этом этапе, согласно Фомину,

произойдёт быстрое и резкое сокращение величины гравитационного воздействия на человека, что нарушит биологические циклы организма. Он сравнивает это состояние с мощным «гравитационным ударом», поскольку человек окажется в среде, к существованию в которой его организм совершенно не приспособлен, и делает вывод, что это, вероятнее всего, приведёт к гибели космонавтов.

Отдельно Фомин рассматривает проблему искусственного тяготения при длительных полётах. Он напоминает, что при продолжительных перелётах к удалённым небесным телам экипажи вынуждены будут долгое время находиться в состоянии невесомости, что небезвредно для организма, и поэтому предполагалось создавать искусственное тяготение за счёт вращения корабля (рис.4)— идею, впервые высказанную К. Э. Циолковским в 1895 году, о придании жилищу человека вращательного движения для создания кажущейся тяжести за счёт центробежной силы (рис.5).

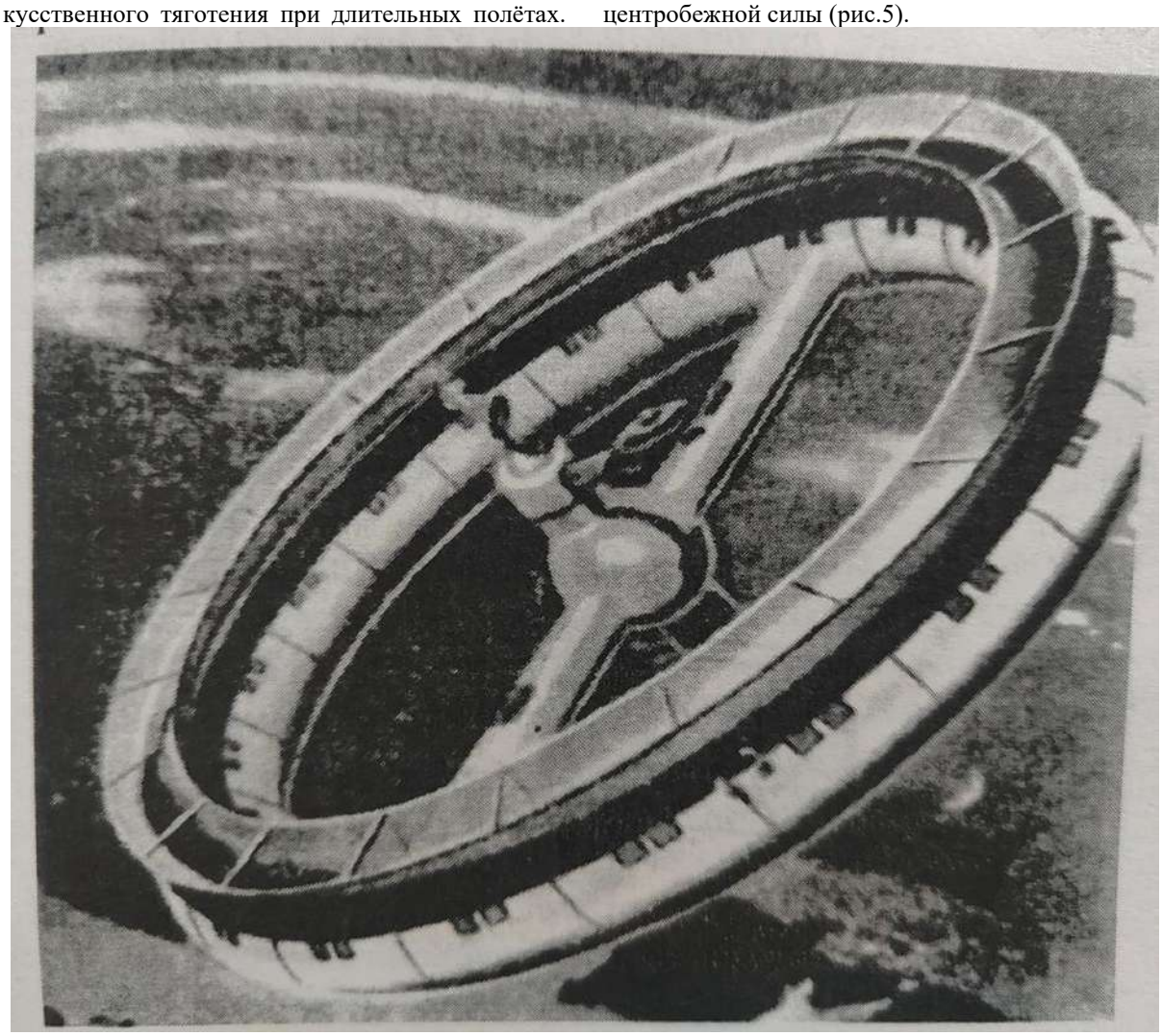

Рис. 4

Однако, указывает Фомин, центробежные силы зависят не только от геометрических размеров конструкции и числа оборотов, но и от интенсивности внешнего гравитационного поля, которое при дальних перелётах будет непрерывно изменяться по мере удаления от планеты и звезды. По его расчётам, для создания искусственного тяготения, равного земному (9,81 см/с^2), за счёт вращения кольцеобразного корабля диаметром около 30 метров при полёте к Венере потребуется вращение со скоростью 1 оборот в секунду (окружная скорость внешней стенки — 380 км/ч); при полёте к Марсу — 7,5 оборота в секунду (2545 км/ч); при полёте к Юпитеру — 30 оборотов в секунду (9864 км/ч). Фомин заключает, что полёт в аппарате, вращающемся с такими скоростями, попросту невозможен.

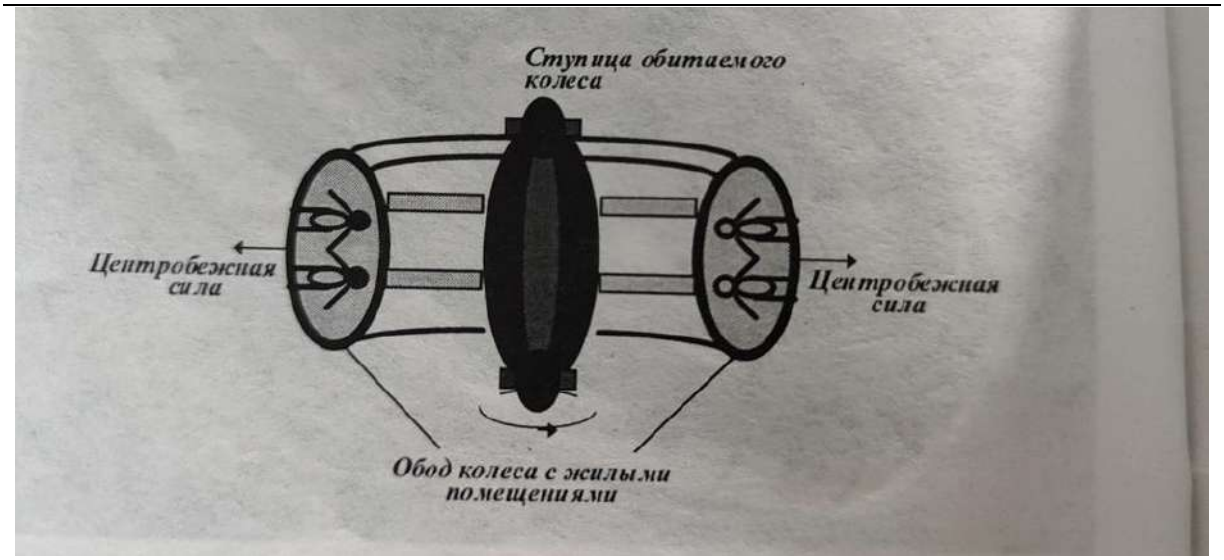

Рис. 5

По его мнению, создание «искусственного тяготения» за счёт вращения в действительности представляет собой лишь имитацию за счёт инерционных сил в неизменном внешнем гравитационном поле — как и «искусственная невесомость» в кабине пикирующего самолёта, — и не воспроизводит изменения внешнего гравитационного поля, а значит, не распространяется на изменение гравитационного воздействия на биологические структуры.

Выводы (по Фомину)

Фомин формулирует следующие итоговые положения своей гипотезы:

1. На любое тело в пространстве действуют гравитационные и инерционные силы; тело обладает своего рода гравитационным зарядом, создающим поле тяготения, проявляющееся дистантно, тогда как инерционные силы отражают явления, наблюдаемые при перемещении тел.

2. Гравитация первична и является неотъемлемым свойством всех материальных тел; инерционные силы вторичны и проявляются только при перемещении тел во внешних гравитационных полях.

3. В каждой точке пространства и в каждый момент времени существует единственная истинная координатная система, основой которой служит результирующий гравитационный вектор — геометрическая сумма всех гравитационных взаимодействий в данной точке.

4. Любой субъект непрерывно находится в изменяющейся гравитационной среде, воздействующей на каждую клетку организма, причём влияние гравитации и инерции на организм, по мнению Фомина, неодинаково.

5. Помимо силовых воздействий, гравитация проявляется на внутриклеточном уровне, менее заметном для наблюдателя; характер этого воздействия зависит от закономерностей колебания результирующего вектора.

6. Циклы изменения гравитационного вектора определяют закономерности процессов в биологических структурах, причём наиболее активно на их состояние влияют резкие изменения вектора, происходящие, по земным наблюдениям, дважды в сутки — около 6 и 18 часов местного времени.

7. Наиболее выраженно воздействие гравитационных сил на биологические структуры, по заключению Фомина, проявляется при космических полётах, где возможны самые различные эффекты — от анабиоза до гравитационного удара.

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PSYCHOLOGICAL SCIENCES

THERAPEUTIC MECHANISMS OF COGNITIVE PROCESSING THERAPY IN ADDRESSING POST-TRAUMATIC COGNITIVE ALTERATIONS

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Abstract

Cognitive Processing Therapy (CPT) is a trauma-focused psychotherapy designed to treat posttraumatic stress disorder (PTSD). It is one of the most researched treatments for PTSD. A large number of studies show it is effective, including in patients with complicated presentations, such as comorbid personality disorders and other co-occurring conditions. CPT has the strongest recommendation as a treatment for PTSD in every clinical practice guideline. Researches have shown that 60-80% of individuals who complete CPT experience a significant reduction in PTSD symptoms, making it one of the most effective therapies available. Veterans and trauma survivors report long-term relief and improved quality of life after completing CPT. Compared to other therapies, CPT has been recognized as one of the most effective and structured approaches to PTSD treatment. By challenging negative thought patterns and restructuring beliefs, individuals can regain emotional stability, confidence, and a sense of control over their lives. The aim of the study is to examine CPT mechanism during the trauma-focused psychotherapy based on literature materials.

Keywords: cognition, cognitive processing therapy, trauma, post-traumatic stress disorders, beleifs scale.

Introduction: Post-traumatic stress disorder (PTSD) is a disabling trauma-related condition characterized by persistent re-experiencing, avoidance, and a heightened sense of current threat. Within the ICD-11 framework, these core symptoms are distinguished from the additional disturbances in self-organization that characterize complex PTSD (Brewin et al., 2017; First et al., 2015). Although diagnostic systems describe PTSD primarily through symptom clusters, contemporary psychological accounts emphasize that the meanings assigned to traumatic experiences are central to the persistence of post-traumatic distress.

Trauma-related cognitions include beliefs and appraisals concerning the self, other people, safety, trust, responsibility, and the meaning of the traumatic event. Such cognitions are clinically important because they can shape how survivors interpret both the trauma and subsequent experiences. Negative beliefs about personal worth, danger, and the trustworthiness of others have been associated with post-traumatic stress symptoms and with broader difficulties following trauma exposure (Jaffe et al., 2019). Accordingly, cognitive change has become a major target of trauma-focused psychotherapies.

Cognitive Processing Therapy (CPT), originally developed by Resick and Schnicke, is a trauma-focused cognitive treatment designed to identify and modify maladaptive interpretations that interfere with recovery (Resick & Schnicke, 1992). CPT conceptualizes problematic post-traumatic beliefs as “stuck points” and uses structured cognitive techniques and Socratic questioning to help patients develop more balanced interpretations of the traumatic event and its consequences. Dismantling research has further supported the importance of the cognitive components of CPT, showing that substantial improvement can occur without requiring the written trauma account that formed part of earlier versions of the protocol (Resick et al., 2008).

The efficacy of trauma-focused psychotherapy is well established, but treatment efficacy and treatment mechanism are not the same question. Demonstrating that symptoms improve during CPT does not by itself establish why they improve. Mechanism research therefore asks whether changes in proposed therapeutic processes occur before, predict, and plausibly contribute to later symptom change (Kazdin, 2007; Zalta, 2015). This distinction is especially important for CPT because its theoretical model explicitly proposes that modification of maladaptive trauma-related cognitions is a central pathway to recovery.

The present article reviews the theoretical and empirical literature on cognitive change as a therapeutic mechanism of CPT. Particular attention is given to the role of maladaptive post-traumatic beliefs, evidence concerning the temporal relationship between cognitive and symptom change, the contribution of specific CPT components, and the measurement of post-traumatic beliefs using the Posttraumatic Maladaptive Beliefs Scale (PMBS). Rather than reporting original empirical findings, the article synthesizes existing evidence and identifies questions that remain unresolved.

Aim of the study: The purpose of this study is to identify role of the cognitive processing therapy during the post-traumatic stress disorders, and cognitive challenges.

Literature Review:

Trauma-Related Cognitions in PTSD

Cognitive accounts of PTSD converge on the proposition that trauma can alter fundamental assumptions about the self, other people, and the world. These alterations may include exaggerated perceptions of

danger, persistent self-blame, diminished self-worth, and generalized mistrust. Such beliefs are not simply descriptions of distress; they may influence avoidance, interpersonal functioning, emotional responses, and the interpretation of subsequent experiences. For example, highlighted the relevance of trauma-related cognitions when examining risk following interpersonal and non-interpersonal trauma, illustrating the broader behavioral significance of post-traumatic beliefs (Jaffe et al., 2019).

This cognitive emphasis is also compatible with the ICD-11 description of PTSD. Persistent perceptions of current threat form one of the three core ICD-11 PTSD symptom clusters (Brewin et al., 2017; First et al., 2015). At the same time, the ICD-11 distinction between PTSD and complex PTSD draws attention to disturbances involving self-concept and relationships, domains that overlap conceptually with beliefs about self-worth and the reliability of others. Cognitive measures therefore provide a useful complementary perspective on post-traumatic adaptation, even though they should not be treated as direct substitutes for diagnostic criteria.

The clinical importance of trauma-related cognitions is reinforced by evidence that cognitive change accompanies improvement during trauma-focused psychotherapy. A recent three-level meta-analysis found a robust relationship between reductions in trauma-related cognitions and reductions in PTSD symptoms across trauma-focused psychotherapies (Keyan et al., 2026). This literature supports the relevance of cognitive change, but association alone does not establish that cognitive modification is the mechanism producing symptom improvement. Establishing a mechanism requires stronger evidence concerning timing, specificity, and causal ordering (Kazdin, 2007; Zalta, 2015).

Cognitive Processing Therapy: Theoretical Basis and Components

CPT was developed as a cognitive treatment for PTSD following sexual assault and was subsequently applied across a range of trauma populations (Resick & Schnicke, 1992). Its theoretical framework focuses on the way traumatic information is integrated into pre-existing beliefs. In CPT, assimilation refers to altering the meaning of the trauma so that it fits prior beliefs, often in ways that preserve inaccurate self-blame, whereas over-accommodation involves broad and extreme changes in beliefs, such as concluding that no person can be trusted or that the world is entirely unsafe. Treatment aims to promote accommodation: a more balanced integration of the traumatic experience into existing beliefs (Watkins et al., 2018).

CPT uses structured cognitive interventions to identify and evaluate stuck points. Patients learn to examine relationships among events, thoughts, and emotions, evaluate the evidence supporting trauma-related interpretations, and develop alternative perspectives. Later portions of treatment address broad belief domains including safety, trust, power and control, esteem, and intimacy. The therapeutic emphasis is therefore not merely on reducing distress while discussing the trauma, but on changing the meanings that maintain maladaptive responses (Resick et al., 2008; Watkins et al., 2018).

Evidence from dismantling research is particularly relevant to the proposed cognitive mechanism. Resick et al. (2008) compared components of CPT and found that the cognitive component alone produced strong outcomes, contributing to subsequent revisions of the treatment protocol. More recent optimization research has continued to examine how CPT can be refined and which elements are necessary or most efficient (Sripada et al., 2023). Such work is important because a treatment can be effective even when the precise active ingredients responsible for improvement remain uncertain.

Cognitive Change as a Mechanism of Therapeutic Improvement

Mechanism research requires more than demonstrating that a proposed mediator and symptoms both improve during treatment. Kazdin (2007) emphasized that a plausible mechanism should show a coherent association with outcome, temporal precedence, and consistency with an explanatory theory. In PTSD treatment research, temporal precedence is particularly important: if cognitive change is proposed to produce symptom improvement, changes in cognition should occur before and predict later changes in PTSD symptoms rather than simply occurring at the same time (Zalta, 2015).

Evidence specific to CPT provides support for this sequence. Schumm et al. (2015) examined changes in post-traumatic cognitions during CPT and found that changes in cognitions predicted subsequent changes in PTSD symptoms. This finding is important because it moves beyond simple pre-post correlation and is consistent with the theoretical proposition that cognitive modification contributes to later symptom reduction. Zalta (2015), reviewing psychological mechanisms of effective cognitive-behavioral treatments for PTSD, likewise identified trauma-related cognitions as one of the better-supported candidate mechanisms while emphasizing that the evidence base remained methodologically limited.

The more recent meta-analytic literature strengthens the general association between cognitive and symptomatic change. Keyan et al. (2026) synthesized evidence on changes in trauma-related cognitions and PTSD outcomes in trauma-focused psychotherapy and found that reductions in maladaptive cognitions were significantly related to reductions in PTSD severity. Importantly, however, a meta-analytic association across treatment studies should not be interpreted as definitive proof of causation. The strongest mechanism claims still depend on repeated measurement, appropriate temporal spacing, tests of competing directional models, and designs capable of separating specific therapeutic processes from nonspecific treatment effects (Kazdin, 2007; Zalta, 2015).

The distinction between efficacy and mechanism is also illustrated by long-term outcome research. CPT-based intensive treatment can produce gains that are maintained over extended follow-up periods, including up to 12 months in veteran samples (Held et al., 2020).

Such findings demonstrate durability of treatment benefit but do not, on their own, identify which process produced that benefit. Long-term follow-up is valuable for establishing maintenance, whereas mechanism research requires sufficiently frequent assessment during the period in which change is occurring. These complementary methodological goals should not be conflated.

The Posttraumatic Maladaptive Beliefs Scale

The Posttraumatic Maladaptive Beliefs Scale (PMBS) was developed by Vogt, Shipherd, and Resick to assess maladaptive beliefs that may emerge or intensify following trauma exposure (Vogt et al., 2012). The instrument contains 15 items and assesses three domains: threat of harm, self-worth and judgment, and reliability and trustworthiness of others. These domains are conceptually relevant to cognitive models of post-traumatic adjustment because they capture generalized beliefs concerning danger, the self, and interpersonal trust.

The PMBS differs from measures that focus narrowly on beliefs about a single traumatic event. Its items assess broader beliefs about current life circumstances, allowing researchers and clinicians to examine how trauma may influence more generalized assumptions. Jaffe et al. (2019) used the PMBS in research on trauma-related cognitions and reported strong internal consistency, supporting its utility for examining individual differences in maladaptive beliefs. Because the domains correspond closely to themes commonly addressed in CPT, the PMBS is also theoretically relevant to research on cognitive change during treatment.

Cross-cultural adaptation studies provide additional evidence regarding the scale's psychometric utility. Anggoh and Purwono (2024) examined an Indonesian version of the PMBS, while Alpay and Usluoğlu (2026) evaluated the Turkish version. These studies extend the measurement literature beyond the context in which the instrument was originally developed and suggest that its underlying domains can be meaningfully examined across different linguistic and cultural settings. At the same time, cross-cultural validation should not be interpreted as evidence that the content or clinical meaning of post-traumatic beliefs is identical across populations. Further research in diverse settings remains necessary.

Clinical and Theoretical Implications

Taken together, the literature supports a clinically meaningful role for cognitive change in CPT. The treatment directly targets maladaptive beliefs, dismantling research supports the effectiveness of its cognitive components, and longitudinal evidence indicates that changes in trauma-related cognitions can precede subsequent symptom change (Resick et al., 2008; Schumm et al., 2015). The broader trauma-focused psychotherapy literature points in the same direction, with meta-analytic evidence linking cognitive improvement to reductions in PTSD severity (Keyan et al., 2026).

These findings have potential implications for clinical monitoring. If maladaptive beliefs are part of the pathway through which CPT produces improvement, systematic attention to stuck points and their change across therapy may help clinicians evaluate whether the intended cognitive process is occurring. Measures such as the PMBS may be useful in this context because they provide structured assessment of beliefs concerning threat, self-worth, and interpersonal trust (Vogt et al., 2012). Nevertheless, current evidence does not justify treating a change in PMBS score as a definitive indicator that the therapeutic mechanism has been activated; measurement of a proposed mediator and demonstration of a causal mechanism are distinct issues.

The literature also has implications for treatment refinement. Component and optimization studies can help determine whether particular CPT procedures are necessary, redundant, or especially influential (Resick et al., 2008; Sripada et al., 2023). This line of work may eventually clarify whether cognitive change is produced primarily by specific worksheets, Socratic dialogue, repeated identification of stuck points, thematic work on safety and trust, or the cumulative structure of the protocol. At present, the evidence is stronger for cognitive change as a broad candidate mechanism than for any single CPT component as the unique active ingredient.

Limitations of the Existing Literature and Directions for Future Research: Several limitations of the existing literature constrain strong causal conclusions. First, many psychotherapy studies were designed primarily to test treatment efficacy rather than mechanisms and therefore assessed proposed mediators and outcomes too infrequently to establish precise temporal ordering (Zalta, 2015). More frequent measurement during CPT would allow researchers to determine whether cognitive shifts reliably precede symptom shifts at clinically meaningful intervals and whether the direction of influence is reciprocal.

Second, evidence that a treatment component is associated with improvement does not establish that the component operates through the hypothesized mechanism. Future studies should connect specific CPT procedures to measurable cognitive change and then test whether that change accounts for later symptom improvement. Factorial and optimization approaches, such as those described by Sripada et al. (2023), are particularly relevant to this question because they can examine the contribution of multiple treatment elements within a structured experimental framework.

Third, the generalizability of mechanism findings requires further attention. CPT has been studied in different trauma populations, including veterans and survivors of interpersonal violence, but the strength and form of cognitive mechanisms may vary according to trauma type, chronicity, cultural context, and clinical complexity. The Turkish and Indonesian adaptations of the PMBS represent useful steps toward broader measurement validity (Alpay & Usluoğlu, 2026; Anggoh & Purwono, 2024), but additional validation and mechanism research in non-Western populations are needed.

Finally, long-term research presents practical challenges. Attrition and difficulties retaining participants can complicate interpretation of psychotherapy follow-up findings (König et al., 2018). Future mechanism studies should therefore combine sufficiently frequent assessment during treatment with longer-term follow-up, while using analytic strategies that account

carefully for missing data and participant loss. Such designs would help distinguish processes associated with immediate improvement from those associated with maintenance of treatment gains.

Conclusion: The literature reviewed here supports the view that modification of maladaptive trauma-related cognitions is a plausible and increasingly well-supported therapeutic mechanism of CPT. CPT is explicitly organized around identifying and modifying distorted beliefs about the trauma, the self, other people, and the world (Resick & Schnicke, 1992; Watkins et al., 2018). Dismantling research demonstrates the clinical potency of its cognitive components (Resick et al., 2008), while longitudinal evidence indicates that cognitive change can precede subsequent PTSD symptom change during CPT (Schumm et al., 2015). Recent meta-analytic findings further demonstrate a consistent relationship between reductions in trauma-related cognitions and PTSD symptoms across trauma-focused psychotherapies (Keyan et al., 2026).

At the same time, the available evidence does not warrant an overly strong causal conclusion. Questions remain regarding the precise temporal dynamics of change, the CPT components that most directly produce cognitive modification, the possibility of reciprocal relationships between cognition and symptoms, and the generalizability of proposed mechanisms across trauma populations and cultural contexts (Kazdin, 2007; Zalta, 2015). The PMBS provides a relevant instrument for studying maladaptive post-traumatic beliefs and has shown promising psychometric properties across several cultural adaptations (Alpay & Usluoğlu, 2026; Anggoh & Purwono, 2024; Vogt et al., 2012). Future research that combines repeated measurement, rigorous component designs, and culturally diverse samples may provide a more precise account of how cognitive change contributes to recovery from PTSD.

Acknowledgments: The author thanks the National Mental Health Centre of Azerbaijan for the valuable contributions.

Source of Funding: This research received no external funding.

Conflict of Interest: The author declares no conflict of interest.

Author contribution: The author solely contributed to the conceptualization, methodology, investigation, writing - original draft preparation, writing - review and editing, and final approval of the manuscript.

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SOCIAL SCIENCES

INTEGRATED ANALYSIS OF RISK FACTORS AND INTERVENTION PRIORITIES FOR SCHOOL DROPOUT PREVENTION

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DOI: 10.5281/zenodo.22030120

Abstract

School dropout is one of the most significant contemporary social and educational problems, with important implications for individual development, labour-market integration, and social inclusion. This study aims to identify the main risk factors associated with school dropout and the interventions considered priorities for its prevention, from the perspective of professionals working in the educational and social sectors. The research is descriptive in nature and uses a mixed-methods approach. The quantitative component was based on an online questionnaire administered to 82 respondents, while the qualitative component involved 21 participants interviewed using a semi-structured interview guide. The findings from the two components were integrated at the interpretive level through a joint display matrix. The results indicate that, according to the participants' perceptions, the risk of school dropout is associated with a range of interrelated factors and highlight the importance of early social interventions tailored to students' needs. The study underscores the need to develop integrated educational and social support programmes aimed at reducing the risk of early school leaving and promoting educational inclusion.

Keywords: school dropout, social interventions, prevention, early intervention, social work, educational inclusion.

1. Introduction

Research Relevance. School dropout represents a major social issue, with significant effects on child development and social inclusion. From the perspective of social work, this phenomenon reflects the existence of situations of social vulnerability associated with poverty, social exclusion, and unequal access to educational resources. Education represents an essential factor for socio-professional integration and the prevention of social marginalization [1, 2].

Specialized studies show that the risk of early school leaving is often preceded by indicators such as repeated absenteeism, declining academic performance, lack of motivation for learning, or difficulties within the family environment, which require prompt and well-coordinated interventions from both the educational and social systems **[3].**

In Romania, school dropout particularly affects children from families experiencing situations of social risk. Studies conducted in the field of social work highlight that parents' low educational level, lack of material resources, and insufficient family support increase the likelihood of early school leaving. Moreover, limited access to social services contributes to the persistence of this phenomenon [**4, 5].**

Children who interrupt their educational pathway frequently face difficulties in social and professional integration, while their families are often exposed to situations of social vulnerability. At the community level, school dropout contributes to the perpetuation of the cycle of poverty and the intensification of social exclusion. Therefore, preventing this phenomenon represents a priority for education and social work systems [**6].**

School Dropout as a Social Problem**.** School dropout represents a complex phenomenon with significant implications for both individuals and society, being considered a major social problem rather than merely an educational failure [7, 8]. It is not limited to leaving school before completing compulsory education but reflects a process of progressive disengagement influenced by individual, family, institutional, and socio-economic factors **[9].**

In Romania and Europe, students from vulnerable backgrounds, such as families with low incomes or limited educational support, face an increased risk of school dropout. These factors, together with absenteeism, poor academic performance, and insufficient educational resources, contribute to increasing social exclusion and limiting opportunities for personal and professional development [**10].**

International research indicates that school dropout is a multidimensional phenomenon generated by the interaction of several categories of factors: individual, school-related, family, and socio-economic. Unlike academic failure, which can be addressed mainly at the school level, preventing school dropout requires integrated interventions and cooperation among multiple

social systems. A meta-analytic study [9] indicates that traditional academic performance indicators, such as grades and absenteeism, are insufficient to predict dropout. Students experiencing social vulnerabilities, such as poverty, lack of family support, or emotional difficulties, have a significantly higher risk of leaving school [9, 11]. These findings highlight the need to develop social policies that complement educational interventions and aim to reduce the risk factors associated with school dropout.

Factors Influencing School Dropout and Its Consequences**.** Recent literature highlights that early school leaving is not the result of a single factor, but rather of a cumulative process that develops over several years and involves both student characteristics and the social and educational environment in which they grow and develop [6]. These factors can be classified into the following categories: socio-economic, familial, individual, psychological, and educational factors.

The specialized literature highlights a strong relationship between early school leaving and an increased risk of social exclusion, poverty, and marginalization. Lack of education reduces access to social and cultural resources and limits individuals' active participation in community life. According to the European Commission, school dropout is associated with a higher risk of poverty, dependence on social assistance, and difficulties in social integration [12].

At the family level, the effects of school dropout tend to be transmitted across generations. Individuals who do not complete their education generally have fewer economic and cultural resources, which may negatively influence the educational trajectories of their own children. Furthermore, the consequences of school dropout are also reflected at the individual level, affecting emotional development and self-esteem. Experiences of academic failure and the absence of a stable educational pathway may lead to decreased motivation, adaptation difficulties, and a negative perception of one's own abilities. Over time, these factors can negatively influence individuals' behavior and social relationships, reinforcing feelings of marginalization [10].

The Role of Social Interventions in Education. Social interventions in education aim to support students through measures that extend beyond the strictly educational framework. These include social assistance services, psychological counselling, material support, and community-based programmes. Alexa and Baciu [4] highlight that the determinants of school dropout in Romania are largely social in nature, including low family income, limited parental education, and insufficient family support.

A key element of social interventions is the promotion of educational inclusion. Students from disadvantaged socio-economic backgrounds are more exposed to school difficulties, absenteeism, and dropout. Through counselling services, psychosocial support, and collaboration with families, specialists can identify and address factors that negatively influence students' educational pathways [13]. Social interventions also play an important role in developing a supportive educational environment.

Miron and Mistrean [14] emphasize the importance of developing institutional monitoring and intervention mechanisms that enable the early identification of educational and social difficulties. Through the involvement of social workers and other specialists, schools can intervene before problems lead to dropout.

Furthermore, social interventions facilitate the relationship between the school and the family, which is considered a determining factor in students' educational success. Milicenco and Gruia [15] demonstrate that the involvement of the social worker in working with families contributes to improving communication between parents and the educational institution, as well as to increasing their level of responsibility regarding their children's education.

Zamfir and Zamfir [16] emphasize that poverty and social exclusion are major factors contributing to school dropout, influencing both students' access to educational resources and their motivation to continue education. Under these conditions, the intervention of social workers becomes essential, having a dual role: supporting students and improving the conditions within their family and community environments.

In high-risk situations, this process often involves collaboration with institutions such as child protection services, non-governmental organizations, or local authorities. Preventing dropout cannot be achieved in isolation but requires an interdisciplinary approach in which cooperation among school, family, and community becomes essential. Within this framework, social workers and school counsellors act as coordinating factors, bringing together and integrating available resources in order to respond effectively to students' needs [17].

One of the essential roles of social workers and school counsellors is the early identification of students at risk of school dropout. This process involves the use of specific assessment and monitoring methods and tools that facilitate the timely recognition of educational and social difficulties. Through early intervention, situations that could subsequently lead to school dropout can be prevented. In this context, the importance of developing integrated support mechanisms at the school level is emphasized, as these enable the implementation of interventions tailored to students' individual needs [18].

At the same time, social workers carry out interventions at the family level, aiming to strengthen the relationship between parents and the educational institution, as well as to support a favourable environment for children's educational development. Collaboration with families represents an essential element in preventing school dropout, as parental involvement significantly influences students' educational pathways. Through counselling and mediation activities, social workers contribute to increasing parental responsibility and improving the support provided to children throughout the learning process [19].

In addition to direct interventions targeting students, specialists play an active role in designing and implementing school dropout prevention programmes, such as *"School after School"* activities, mentoring programmes, and material support initiatives. These

measures are not limited to improving academic performance but also contribute to strengthening students' connection with the educational environment. Through continuous involvement and a child-centred approach focused on the individual needs of each student, specialists contribute to creating an inclusive school environment, providing every learner with the opportunity to develop and fulfil their potential. Collaboration with all relevant community stakeholders enables these professionals to become key actors in reducing the risk of social and educational exclusion [20].

Howard Adelman and Linda Taylor [21] emphasize the importance of developing integrated support systems within schools, where counsellors and social workers collaborate to create rapid intervention networks. They argue that the effectiveness of school dropout prevention increases significantly when interventions are coordinated and implemented simultaneously at educational, psychological, and social levels.

2. Research Methodology and Findings

Within this paper, the phenomenon of school dropout and the role of social interventions in its prevention were explored through a mixed-methods research approach, combining quantitative and qualitative research methods. The study was designed to provide a comprehensive understanding of how social workers and school counsellors contribute to reducing the risk of school dropout, both through direct activities with students and through the coordination of educational and social resources.

2.1. Quantitative Component: Method and Results

The quantitative research design involves the analysis of respondents' opinions, perceptions, and individual experiences by transforming them into numerical data that can be statistically analysed in order to identify trends, relationships, and patterns within the investigated population, using the survey method [22].

The purpose of the quantitative research is to identify the factors contributing to the risk of school dropout and to assess the perceptions of specialists within educational institutions regarding the effectiveness of social interventions.

The formulated objectives are:

- Objective 1: Identifying the main factors contributing to the risk of school dropout from the perspective of education specialists.
- Objective 2: Assessing specialists' perspectives regarding the effectiveness of social interventions in combating and preventing school dropout.

General hypothesis: Social interventions implemented in educational institutions reduce the risk of school dropout and contribute to keeping students within the educational system, according to the perceptions of teachers and specialists.

✓ Hypothesis 1: If the level of socio-economic factors is low, then the risk of school dropout is considered higher.

✓ Hypothesis 2: If social interventions (school counselling, family support, educational programmes) are implemented, then the risk of school dropout can be reduced.

The instrument used in the quantitative research was an online questionnaire developed through the Google Forms platform. It was structured to allow the collection of data regarding respondents' profiles, their perceptions of factors influencing school dropout, the evaluation of the effectiveness of social interventions, as well as their general opinions regarding the need for additional measures to prevent this phenomenon.

The questionnaire was divided into five sections: perceptions of school dropout, factors influencing school dropout, social interventions, general opinions, and identification data. It consisted of 12 questions, including an open-ended question designed to collect additional opinions and suggestions from respondents.

The sample consisted of 82 respondents, including teachers, class coordinators, school counsellors, social workers, school psychologists, and educators selected from different educational institutions and organizations (Mircea Eliade National College, Secondary School No. 7, Traian Lalescu National College, "Children of Jesus" Day Centre, UBB Reșița University Centre, and the Banat Mountain Economic College), in order to ensure a diverse and representative perspective on the phenomenon.

By analysing the responses received from the surveyed participants, the conclusions related to the formulated hypotheses are presented:

✓ The descriptive findings were consistent with Hypothesis 1 at the level of respondents' perceptions. Thus, 97.8% of respondents considered school dropout to be a major problem in contemporary society. The most frequently identified factors were lack of family support and disengagement from school (68.3%), students' emotional problems (58.5%), and material hardship (53.7%) (Table 1). These findings reflect the importance attributed by respondents to family, emotional, and socio-economic factors without demonstrating causal relationships.

Table 1

Risk Factor–Intervention Matrix

Identified risk factor	Reported percentage	Descriptive priority level	Associated intervention	Qualitative evidence	Responsible professional /institution
Lack of family support and disengagement from school	68.3%	High	- Family counselling; - school–family mediation; - guidance and remedial activities	Participants describe the family as either a protective or a risk factor and also state that students no longer perceive school as useful	Social worker / school counsellor
Emotional problems	58.5%	High	- Individual and psychoeducational counselling	The interviews mention demotivation and lack of support	Psychologist / counsellor
Material hardship	53.7%	Moderate to high	- Scholarships; - material support; - community services	Respondents report difficulties related to school-related expenses	School / social services

✓ With regard to Hypothesis 2, the descriptive findings were consistent with the hypothesis at the level of respondents' perceptions. Thus, 91.3% of respondents considered social interventions to contribute to reducing school dropout. When asked which types of intervention they regarded as the most effective for preventing and reducing school dropout, respondents most frequently selected school counselling 75.6% and family support 73.2% (Table 2). These findings highlight the perceived importance of social and educational interventions in keeping students within the education system and reducing the risk of dropout. The high percentage attributed to school counselling indicates that respondents value the emotional, psychological, and educational support provided to students. Furthermore, 80.5% of respondents perceived school counselling as one of the most effective forms of support for students at educational risk. Through counselling activities, students may receive emotional support, educational guidance, and assistance in managing personal, family, or social difficulties that could negatively affect their educational trajectory. The role of the school counsellor or social worker in preventing and reducing school dropout was rated as important or very important by 84.8% of respondents. This result shows that most study participants recognise the importance of specialised intervention in managing and reducing the risk of school dropout.

Table 2

Social Interventions Most Frequently Indicated by Respondents

Social intervention	Reported percentage	Rank
School counselling	75.6%	1
Family support	73.2%	2

Note. Respondents could select multiple response options; therefore, the percentages do not add up to 100%.

2.2. Qualitative Component: Method and Results

In order to explain the issue of school dropout, a sociological survey based on a semi-structured interview guide was conducted, with the aim of deepening and complementing the quantitative research through relevant qualitative data.

The research sample consisted of 21 respondents, including teachers, school counsellors, and social workers from various organisations and educational institutions (Mircea Eliade National College, Secondary School No. 7, Traian Lalescu National College, "Children of Jesus" Day Centre, UBB Reșița University Centre, and the Banat Mountain Economic College). The participants were selected based on the criterion of direct involvement in working with students at risk of school dropout.

The purpose of the qualitative research was to explore in depth the perceptions of specialists and teaching staff regarding the factors contributing to the risk of school dropout and the effectiveness of social interventions in preventing this phenomenon.

Objectives of the qualitative research:

- *Objective 1:* Determining factors contributing to school dropout.
- *Objective 2:* Exploring specialists' perspectives regarding the effectiveness of social interventions in preventing and addressing school dropout.

The structure of the interview guide was based on two thematic units:

✓ *Thematic Unit 1*: Identification of the main factors contributing to the risk of school dropout from the perspective of education specialists. This thematic unit was explored through five supporting questions.

✓ *Thematic Unit 2*: Analysis of the effectiveness of social and educational interventions in preventing and reducing school dropout from the perspective of specialists. This thematic unit was explored through four supporting questions.

By analysing the responses provided by education specialists to the supporting questions of Thematic Unit 1, concerning the factors contributing to the risk of school dropout, the following conclusions were drawn:

- The phenomenon of school dropout in contemporary society is perceived by specialists as a concerning issue with long-term effects both on students and on society as a whole. It is described as "an increasingly present phenomenon, especially in vulnerable environments", where "students give up school more easily than in the past" and where the phenomenon "often begins as early as primary school due to a lack of interest in education". These aspects represent warning signs regarding insufficient support or reduced motivation among some students. In many cases, school dropout is associated with emotional, family, or social difficulties.
- School dropout is considered an important issue because it reduces employment opportunities, increases the risk of social exclusion, and may contribute to the perpetuation of poverty and social inequalities. Specialists highlighted that it "affects students' future and contributes to social inequalities" and that it "contributes to the perpetuation of social problems such as poverty and exclusion". School dropout limits opportunities for professional integration and personal development, as "the lack of education reduces employment opportunities and personal development prospects. Moreover, it can lead to social exclusion and long-term difficulties. Therefore, preventing this phenomenon should be a priority."
- The causes of school dropout are determined by a series of interconnected factors, among which precarious socio-economic conditions, lack of family support, and disadvantaged social environments are particularly significant. One participant stated that "school dropout occurs when students fail to adapt to school requirements or do not feel emotionally and socially supported", highlighting the importance of school integration and emotional support in maintaining students within the education system. Other identified causes include poor academic results, lack of motivation, peer influence, lack of interest in education, the perception that "students do not see the usefulness of school or do not have the necessary support to continue", as well as limited access to educational resources.
- Socio-economic conditions significantly influence school dropout. Families with low incomes may experience difficulties in covering educational expenses, while some children may be required to work in order to contribute to family income, which can result in leaving school. Specialists noted that "socio-economic conditions directly influence school participation, with students from families with limited resources being more vulnerable to dropout". The lack of material resources and adequate living conditions negatively affects students' attendance and participation in education. Financial stress affects both students and their families.
- Family and social environments play an essential role in preventing or facilitating school dropout. A supportive family that encourages education and provides emotional support can reduce the risk of dropout, as "family can have both a positive and a negative role. Parental involvement in education is essential, while its absence frequently contributes to dropout." Conversely, family conflicts, lack of interest in education, or negative peer influences may favour school disengagement. Specialists emphasised that "family and the social environment have an essential role in preventing or encouraging school dropout. A family that supports children's education can increase motivation and interest in school, whereas lack of involvement or negative role models may contribute to leaving education. Furthermore, the social environment in which students live can influence their attitudes towards education."

Regarding the second thematic unit, which focused on analysing the effectiveness of social and educational interventions in preventing and reducing school dropout, the participants' responses revealed the following:

- Social and educational interventions are perceived as essential in reducing and preventing this phenomenon. Participants highlighted that "the most effective interventions are integrated ones, combining educational support with social and material assistance. In practice, programmes such as *'School after School'*, family counselling, and the provision of social scholarships have positive outcomes in preventing dropout." The interviewed specialists consider early intervention to be the most effective strategy for reducing the risk of school dropout, as it enables the identification and support of students before difficulties become more severe. One participant stated that "early interventions, school counselling, and educational support programmes are the most effective measures for reducing school dropout", emphasising the importance of a preventive and structured approach. In this context, school counselling is perceived as an essential component in identifying students at risk, as well as in providing emotional and educational support adapted to their specific needs. Furthermore, the need for personalised interventions tailored to each student's individual situation was emphasised, ensuring that the support provided is effective and relevant: "the most effective interventions are case-based personalised interventions, in which both the student and the family are involved. Financial support, counselling, and the involvement of community services are essential for reducing the risk of dropout."
- The school counsellor has an essential role in the early identification of risk factors and in providing psycho-educational support to students. The school counsellor assesses students' needs, conducts individual and group counselling activities, develops school dropout prevention programmes, and facilitates communication between students, families, and teachers. Participants emphasised that the counsellor "contributes to identifying problems that may lead to dropout and proposes appropriate intervention strategies. Through guidance and personal development activities, the counsellor supports students in clarifying their objectives and increasing their self-confidence. They also play an important preventive role through programmes and activities carried out at school level." The school counsellor also acts as a mediator between school and

family and contributes to conflict resolution. Furthermore, the counsellor supports the development of students' learning motivation, self-esteem, and school integration, particularly among vulnerable students, by "providing emotional support and helping students overcome personal or educational difficulties" and "contributing to the prevention of adaptation problems."

- Reducing school dropout requires the implementation of complex measures, such as the early identification of students at risk and the development of psycho-educational counselling services. It is necessary to expand educational and social support programmes, provide scholarships and other forms of financial assistance, encourage active parental involvement in the educational process, and strengthen collaboration between schools, local authorities, and social services. Participants highlighted that "prevention programmes should begin early, with stronger involvement from schools and social services, as well as continuous support for families experiencing difficulties. Reducing social inequalities is also highly important." Other recommendations included "educational policies better adapted to social realities" and "integrated interventions including financial support, social counselling, and educational programmes adapted to students at risk. Early prevention is extremely important."

- Family and community support are considered highly important for the success of social interventions. Participants emphasised that "when both are involved, the chances of preventing dropout increase considerably." Parental involvement in school life contributes to increasing students' motivation, improving attendance, and developing a favourable learning environment. As one participant noted, "school interventions have limited effects if the student does not have a stable and supportive environment at home. In practice, when parents actively collaborate with the school and show involvement, the chances of preventing dropout increase significantly." Students require continuous support both at home and within their social environment in order to remain engaged in education. Furthermore, "the family can encourage the child, monitor academic progress, and collaborate with teachers, with the primary goal being the child's best interest and harmonious development." At the same time, collaboration between schools, local authorities, social services, non-governmental organisations, and other community stakeholders enables the provision of comprehensive support adapted to the needs of students experiencing vulnerability.

2.3. Integration of Quantitative and Qualitative Results

The results were integrated at the interpretive level using a *joint display* matrix, in which the aggregated quantitative findings were aligned with the themes identified in the qualitative responses (Table 3) [23].

Table 3

Joint Display Matrix Integrating the Quantitative and Qualitative Results

Dimension	Quantitative result	Qualitative result	Integrated interpretation
Lack of family support	68.3% identified lack of family support and disengagement from school as factors influencing school dropout	The family is described as both a protective factor and a risk factor	The findings converge on the central role of the family
Emotional problems	58.5% identified emotional problems as a factor influencing school dropout	Participants mention adjustment difficulties, demotivation, and lack of support	Emotional support should be included in preventive interventions
Economic vulnerability	53.7% identified material hardship as a factor influencing school dropout	The interviews describe some families' inability to cover education-related expenses	Material support should be combined with educational intervention
School counselling	75.6% identified counselling as an important intervention	The counsellor is described as a mediator, support provider, and intervention coordinator	The findings support the role of counsellors in identifying and managing the risk of school dropout
Family support	73.2% identified family support as an important intervention	Participants state that school-based intervention has limited effects without family involvement	Interventions should target both the student and the family
Social interventions	91.3% consider that social interventions contribute to reducing school dropout	Participants favour early, integrated, and personalised interventions	There is a favourable professional perception of integrated interventions, although their actual effectiveness was not demonstrated

The integrated findings reveal substantial convergence between the quantitative and qualitative components. The factors most frequently identified in the questionnaire—particularly lack of family support, emotional problems, and material hardship—also emerged in the participants' interview accounts. The qualitative data complement the descriptive findings by explaining the mechanisms through which these vulnerabilities may affect school participation.

Similarly, school counselling, family involvement, and early interventions were viewed favourably in both components of the study. This convergence does not demonstrate the objective effectiveness of the interventions; however, it indicates a professional consensus regarding the need for an integrated approach targeting the student, family, school, and community simultaneously.

The study has several methodological limitations that should be considered when interpreting the findings. The convenience sample included professionals from a limited number of institutions; therefore, the findings cannot be generalised to the entire education system. The quantitative data reflect respondents' perceptions rather than direct measurements of school dropout or the effects of social interventions.

Furthermore, the quantitative analysis was based on the available aggregated descriptive findings, which did not allow relationships between variables, differences across professional groups, or inferential statistical testing of the hypotheses to be examined. The quantitative and qualitative components were integrated at the interpretive level by aligning the descriptive findings with the themes identified in the qualitative responses. Therefore, the findings should be interpreted as indications of professionals' perceptions and priorities rather than as evidence of the objective effectiveness of the interventions examined.

3. Conclusions

The study of this phenomenon was based on the premise that school dropout is a complex social problem influenced by multiple interrelated factors and requiring multidimensional interventions to be effectively prevented and addressed.

Within the limitations of the descriptive nature of the research, the findings indicate a professional consensus regarding the importance of early and integrated interventions.

The quantitative and qualitative findings confirmed that participants perceive school dropout as an important and current problem requiring attention and intervention from educational and social institutions.

The main perceived risk factors for school dropout include families' financial difficulties, lack of parental support and involvement, disadvantaged social environments, student demotivation, poor academic performance, and limited access to educational resources. According to the professionals, these factors do not operate in isolation but interact with one another, increasing students' vulnerability and the risk of early school leaving. The findings also showed that socio-economic circumstances are perceived as influencing school participation and may constitute an important determinant of dropout risk.

The study also highlighted the importance of early interventions and collaboration among schools, families, and communities in preventing school dropout. Participants considered that educational support measures, school counselling, and active family involvement may contribute to keeping students within the education system. These findings suggest that dropout prevention requires not only student-centred interventions but also measures targeting the family and community environments.

The analysis of the professionals' responses indicates that school dropout is a complex phenomenon shaped by the interaction of individual, family, socio-economic, and educational factors, requiring sustained and multidimensional interventions. Participants considered that this phenomenon has major consequences for both students' personal and professional development and society as a whole, contributing to the perpetuation of poverty, social exclusion, and inequalities of opportunity.

Preventing and reducing school dropout depend on the implementation of integrated, personalised, and timely interventions. Professionals considered early intervention, psychoeducational counselling, educational and social support programmes, and material assistance for students from vulnerable backgrounds to be among the most effective perceived measures for preventing school dropout. The role of the school counsellor was also regarded as essential in identifying students at risk, providing emotional and educational support, and facilitating collaboration among students, families, and schools.

The findings further emphasise the importance of active family and community involvement in supporting students' educational trajectories. Collaboration among schools, families, local authorities, social services, and community organisations is considered essential for the effectiveness of interventions and for providing support adapted to the needs of vulnerable students. The findings therefore support the development of coordinated and sustainable interventions aimed both at addressing the perceived causes of school dropout and at creating an educational environment conducive to the participation and academic success of all students.

The implementation of public policies and integrated educational and social support programmes is essential for reducing the risk of early school leaving and strengthening educational inclusion. Coordinated approaches and interventions tailored to students' needs can help create the conditions necessary to ensure equitable access to education and support students in remaining within the school system.

Declaration on the Use of Artificial Intelligence

ChatGPT was used for English-language translation and grammar revision.

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HEALTHY FOOD SERVICES IN SPORTS TOURISM: A WELLNESS PERSPECTIVE

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Abstract

The growing demand for health-oriented travel has strengthened the integration of sports tourism, gastronomy, and wellness services. This study examines the role of healthy restaurant products in meeting the nutritional and gastronomic needs of athletes and sports tourists through two core components: culinary production and catering services. A conceptual analysis based on current scientific literature evaluates the technological, nutritional, and service characteristics of restaurant products within sports tourism. Attention is given to food quality, nutritional value, organoleptic properties, freshness, presentation, packaging, and compliance with healthy eating principles. The findings indicate that competitive restaurant products should integrate balanced nutrition, local ingredients, sustainability, and innovative food technologies while maintaining sensory quality. Flexible menus and wellness-oriented catering services can accommodate the specific dietary requirements of athletes and active travelers, enhancing customer satisfaction and recovery. Integrating healthy restaurant products into sports tourism contributes to destination competitiveness, sustainable tourism development, and the promotion of wellness-oriented travel experiences.

Keywords: sports tourism, wellness-foot, culinary production, catering, sustainable tourism.

Introduction

Growing awareness of healthy lifestyles has substantially influenced consumer behavior within the tourism and hospitality sectors, increasing demand for products and services that integrate health, nutrition, and well-being (7, 16, 20). Tourism has consequently evolved into an important niche of the tourism industry, combining physical activity, recreation, and travel while responding to the expectations of health-conscious consumers (2, 3, 9, 23). Within this context, healthy restaurant products have emerged as an essential component of the sports tourism experience (4, 15, 18). Beyond providing nutritionally balanced meals, it incorporates sustainable food production, local ingredients, functional nutrition, and high-quality catering services that support athletic performance, recovery, and overall well-being (6, 19, 21). Contemporary sports tourists increasingly expect restaurant products that combine nutritional value with sensory quality, sustainability, convenience, and innovative service concepts (1, 12, 17). Recent developments in the restaurant industry demonstrate a growing tendency to revise recipes, optimise technological processes, and improve food presentation to preserve nutritional quality and organoleptic characteristics during preparation and thermal processing (11, 13, 14). Attention is directed towards freshness, portion size, packaging, and catering solutions adapted to the specific requirements of athletes and physically active tourists (10, 22). These developments reflect the broader transition towards healthier dietary patterns and wellness-oriented gastronomic experiences (8, 17). The present study examines the role of healthy restaurant products in satisfying the nutritional and gastronomic needs of athletes and sports tourists (5). Emphasis is placed on the two principal components of the restaurant product—culinary production and catering services—and their contribution to sustainable sports tourism and wellness-oriented destination development.

Methods

This study applies to a qualitative conceptual approach based on the systematic analysis of scientific literature and the synthesis of contemporary theoretical and practical knowledge concerning healthy restaurant products within sports tourism. The analysis focuses on the two fundamental components of the restaurant product: culinary production and catering services. Culinary production was examined with respect to nutritional composition, caloric value, technological processing, organoleptic quality, freshness, packaging, and compliance with healthy dietary recommendations (19). Additional attention was given to gastronomic traditions, preparation methods, and technological innovations designed to preserve the nutritional and sensory qualities of food products. Catering services were analysed as an integral element of the overall restaurant product, considering their role in service quality, customer experience, atmosphere, and the organisation of food provision during sports events. Emphasis was placed on the flexibility of restaurant products to accommodate the specific nutritional requirements of athletes through diversified menus, functional foods, healthy beverages, and portable catering solutions. The conceptual framework also incorporates principles of sustainable nutrition, including increased consumption of fruits, vegetables, whole grains, legumes, nuts, and unsaturated fats, together with reduced intake of processed foods and products with a high environmental footprint (Fig. 1).

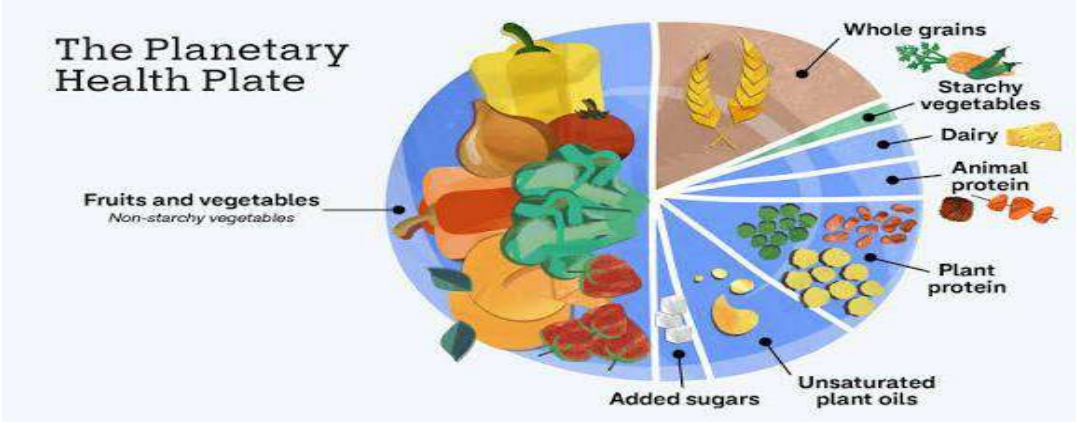

Fig. 1. Diet for Planetary Health (The EAT-Lancet Scientific Committee, published in the authoritative journal Lancet 2024) Source: https://www.espressonews.bg/

These principles provide the basis for evaluating healthy restaurant products as an essential component of contemporary sports tourism and wellness-oriented hospitality.

The Planetary Health Diet (Fig. 1) provides a scientifically grounded framework for healthy and sustainable nutrition by recommending increased consumption of fruits, vegetables, whole grains, legumes, nuts, and plant-based oils, together with moderate intake of dairy products and limited consumption of animal-derived foods. This dietary model supports both human health and environmental sustainability and is increasingly recognised as an appropriate nutritional reference for sports tourism and wellness-oriented hospitality. The composition of culinary products and ready-to-consumer foods determines the characteristics and market positioning of the restaurant product (16, 17). Owing to its flexibility, the restaurant product can satisfy both primary nutritional requirements and complementary dietary needs of athletes and sports tourists. According to Axler (1979), the restaurant product comprises a primary component (food and beverages) and a secondary component, including comfort, communication, entertainment, and customer experience. This broader interpretation reflects the growing importance of experiential value in contemporary sports tourism. Recent developments in hospitality indicate a shift towards open-kitchen concepts, live culinary preparation, and transparent food production, allowing consumers to observe the preparation and presentation of meals. Together with innovative catering services, these approaches increase customer confidence, improve service quality, and enhance overall tourism experience during sporting events. The restaurant product in sports tourism can be conceptualised as consisting of three interrelated components: (i) food and beverages, (ii) service quality, and (iii) the service environment or atmosphere. These components jointly determine customer satisfaction and the perceived quality of the gastronomic experience. Service quality represents a critical element of sports tourism, particularly during large-scale sporting events where rapid, hygienic, and efficient food provision is essential. Modern catering services include diversified delivery methods, mobile food stations, tray service, and live food preparation, enabling restaurants to respond effectively to the specific nutritional requirements of athletes and visitors. Consequently, catering extends beyond food provision and becomes an integral part of the overall tourism product. The atmosphere in which the restaurant product is delivered further contributes to customer satisfaction by combining gastronomic quality with the emotional and social dimensions of sporting events. Themed restaurants, sports-oriented environments, and destination branding strengthen visitor engagement and reinforce memorable tourism experiences. Consequently, contemporary restaurant products should integrate high-quality culinary production, efficient service technologies, attractive atmospheres, and wellness-oriented nutritional principles to achieve greater competitiveness within the sports tourism market.

Results

The findings indicate that the availability of healthy restaurant products at sports venues has become an essential requirement for meeting the nutritional demands of athletes, accompanying personnel, and visitors. Such demand is primarily addressed by large restaurant chains and quick-ser ice operators capable of providing efficient catering under time-constrained event conditions. Market analysis demonstrates that successful food-service providers increasingly adopt strategies focused on continuous menu innovation, the use of higher-quality ingredients, service quality improvement, technological modernisation, and investment in infrastructure. These strategies strengthen competitive advantage while supporting sustainable business development. Furthermore, investment in staff training and organisational development enhances service efficiency and contributes to the long-term competitiveness of restaurant operations within sports tourism. The analysis demonstrates that the quality of the restaurant product represents a key determinant of customer satisfaction and competitiveness in sports tourism. Although the atmosphere of sports-themed restaurants contributes to visitor experience, culinary quality and service efficiency remain the primary factors influencing consumer choice and repeat visitation.

The increasing diversity of sports tourists requires restaurant operators to adopt differentiated market strategies and to develop products tailored to specific nutritional and lifestyle preferences. Large restaurant

chains and quick-service establishments have responded by improving menu quality, modernising production technologies, investing in service innovation, and strengthening organisational capacity. These measures contribute to greater market competitiveness while improving the quality of the tourism experience. Successful examples from international practice, including sports club restaurants and themed hospitality concepts, demonstrate that integrating gastronomy with the identity of sporting events enhances destination attractiveness and customer engagement. Such concepts combine healthy nutrition with entertainment, branding, and experiential value, creating additional opportunities for sports tourism development. The analysis further indicates that the competitiveness of restaurant products depends on the successful integration of culinary quality, nutritional value, sensory characteristics, service quality, and pricing strategy. Healthy menus designed according to recognised nutritional standards, such as the Nutri-Score classification. The tool assigns 1 to 10 points for ingredients to limit (ie calories, saturated fat, sugars, salt) and 0 to 5 for beneficial ingredients (protein, fiber, fruits and vegetables, nuts) provide consumers with transparent information and facilitate healthier food choices(Fig. 2).

Fig. 2. The Nutri-Score system is designed for labeling products.
Source: Photo: eutoday.net Examples of Nutri-Score labeling

Consequently, nutritional labelling has become an important instrument for promoting healthy eating behavior within sports tourism.

Discussion

The findings confirm that healthy restaurant products should be considered an integral component of the sports tourism value chain rather than an auxiliary hospitality service. Competitive advantage increasingly depends on the ability of restaurant operators to combine nutritional quality, sustainability, technological innovation, and customer-oriented service. The integration of healthy culinary production with efficient catering services creates added value for athletes and sports tourists by supporting physical performance, recovery, and overall well-being. These findings are consistent with current trends in wellness tourism, which emphasise holistic experiences combining nutrition, health promotion, sustainability, and personalised services. The adoption of internationally recognised nutritional assessment systems, such as Nutri-Score, contributes to greater transparency and supports informed consumer decision-making. Overall, the results suggest that the competitiveness of sports tourism destinations increasingly depends on the successful integration of healthy gastronomy, service quality, and destination branding into a coherent wellness-oriented tourism product.

Conclusion

Healthy restaurant products constitute an essential component of contemporary sports tourism by combining balanced nutrition, high-quality catering services, and sustainable hospitality practices. Their successful integration into sports tourism enhances customer satisfaction, supports athletes' nutritional requirements, and strengthens destination competitiveness. Restaurant operators should continuously adapt their products and services to evolving consumer expectations by emphasising healthy menus, local ingredients, sustainable production, innovative service technologies, and transparent nutritional information. The implementation of recognised nutritional standards and wellness-oriented gastronomic concepts provides additional opportunities for product differentiation and market positioning.

Acknowledgement:

Conflict of Interest: *The author and the institution declared no conflict of interest.*

Financial Disclosure: *The article is under the implementation of project BG16RFPR002-1.014-0011 Sustainable Development of the Centre of Excellence "Heritage BG," funded under the grant aid procedure BG16RFPR002-1.014 "Sustainable Development of Centres of Excellence and Centres of Competence, Including Specific Infrastructures or Their Associations from the National Roadmap for Scientific Infrastructure".*

Declarations *of informed consent have been signed regarding the publication of survey data.*

ChatGPT is used for English grammar revision and translation.

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Anschrift: Industriestraße 8,74589 Satteldorf Deutschland.

E-mail: info@dizzw.com
WWW: www.dizzw.com

Chefredakeur: Reinhardt Roth

Druck: Einzelfirma Artmedia24, Industriestraße 8,74589 Satteldorf Deutschland

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Address: Industriestrasse 8,74589 Satteldorf Germany.

E-mail: info@dizzw.com
WWW: www.dizzw.com

Editor in chief: Reinhardt Roth

Printing: Artmedia24, Industriestrasse 8,74589 Satteldorf Germany.

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Materials are publishing in author's edition.

ISSN (Print) 2701-8369

ISSN (Online) 2701-8377

Edition: № 134/2026 (August) – 134th

Passed in press in August 2026

Printed in August, 2026

Printing: Artmedia 24, Industriestrasse 8,

74589 Satteldorf, Germany.

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